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MEET THE AUTHORS OF OUR ANNIVERSARY BOOK

This is the concluding review of the biographies of the men who are contributing chapters to our 50th anniversary book. This book will appear in early fall of 1950. Senior author of the chapter on History of the Biological Sciences (John C. Mayfield is junior author) is

JEROME ISENBARGER

He is a graduate of Indiana State Normal and holds a B.S. degree from Indiana University. Graduate work in Biology was carried at Chicago University. As teacher, Mr. Isenbarger served Louisville Male H. S., Senn H. S. at Chicago. At this latter city he also taught at the following schools: Crane Junior College, Wright Junior College, Lewis Institute, North Park College and Loyola University. At Evanston, Illinois he was affiliated with National College of Education. At present he is on the staff of Loyola University in Chicago. Mr. Isenbarger is co-author of the book *Practical Problems in Botany*, a John Wiley publication. Mrs. Isenbarger is chairman of the editorial committee of our anniversary book. She and a son and daughter are the members of the intimate family group. The author has been on the membership list of CASMT since 1911, and served as its president in 1919.

The chapter "A Half Century of Training Science and Mathematics Teachers" is being written by Dr. John S. Richardson and Dr. G. P. Cahoon of the Ohio State faculty.

DR. JOHN S. RICHARDSON

He was awarded both the B.S. and M.A. degrees by Miami University, and the Ohio State University claims him as alumnus for graduate work leading to conferral of the Ph.D. degree. For three

years he taught at Warren County, Ohio high school, for eleven years he was on the staff of Miami University, and since 1947 he is connected with the faculty of Ohio State University. Dr. Richardson is co-author of "Demonstrations and Laboratory Experiences in the Science of Aeronautics" and of "Methods and Materials in the Teaching of Science." The latter constitutes Chapter III, October issue (1948) of *Review of Educational Research*. He is also a liberal contributor to our SCHOOL SCIENCE AND MATHEMATICS. Besides his wife there are three children in the family group. Dr. Richardson became affiliated with CASMT in 1937.

DR. G. P. CAHOON

Hamline University (Minnesota) conferred on him the B.S. degree, and from the University of California he received both the M.A. and Ph.D. degrees. Teaching service was given schools at La Crosse, Wisconsin, Stockton, California, University School at Ohio State and finally Ohio State University. Here he is a member of the faculty at the present time. His membership with CASMT dates back to 1920. Besides articles contributed to various magazines, he is co-author of *Demonstrations and Laboratory Experiences in the Science of Aeronautics*. His wife Lucille, two sons and two daughters constitute the family group.

J. E. POTZGER

AWARDS FOR RESEARCH

Pi Lambda Theta, *National Association for Women in Education*, announces two awards of \$400 each, to be granted on or before August 15, 1950, for significant research studies in education.

An unpublished study may be submitted on any aspect of the professional problems and contributions of women, *either in education or in some other field*. Among others, studies of women's status, professional training, responsibilities and contributions to education and to society, both in this country and abroad, will be acceptable.

No study granted an award shall become the property of Pi Lambda Theta, nor shall Pi Lambda Theta in any way restrict the subsequent publication of a study for which an award is granted, except that Pi Lambda Theta shall have the privilege of inserting an introductory statement in the printed form of any study for which an award is made.

A study may be submitted by any individual, whether or not engaged at present in educational work, or by any chapter or group of members of Pi Lambda Theta.

Three copies of the final report of the completed research study shall be submitted to the Committee on Studies and Awards by June 1, 1950. Information concerning the awards and the form in which the final report shall be prepared will be furnished upon request. All inquiries should be addressed to the chairman of the Committee on Studies and Awards.

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CIVILIZATION IN A QUANDARY*

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The human race, civilized or not, has always existed in an atmosphere of struggle, frustration and indecision. Since the beginning of *genus homo*, groups of men and women have been faced with starvation, disease, inadequate shelter, disaster, animals and other men, as enemies. They have been handicapped in their struggles by ignorance, prejudice, hatred, physical debility, mental inertia and stupidity. Despite all this, man has, over a period of a few thousand years, succeeded in completely changing his lot and, occasionally, had an enjoyable time doing it. He has made substantial headway in adapting himself to his earthly environment and remarkable progress is shaping his terrestrial domain to his desires and physical needs.

If, ten thousand years ago, bets could have been placed on the ultimate achievements of certain harassed, and probably filthy, bands of two-legged mammals, the odds would certainly have been stacked heavily against these unhappy men and women who were our forebears. They were devoid of claws and fangs and inadequately protected against the weather. Their only asset was a disproportionately large brain case, well filled with grey matter. Intellectual processes—application of rudimentary logic, mixed with occasional flashes of genius—came in to play with such effectiveness that man now completely dominates the globe and largely bends it to his will. The only really significant enemy he has left is himself—and here arises the quandary which he must meet and solve or slip into a state of retrogression.

The quandary is essentially simple in structure. It merely involves the reconciliation of the requirements of two things, each of which is inherently of great and lasting value in its own right. These two things are:

- Item I—Our increasing mastery of science and ability to produce goods and services.
- Item II—Our desire to maintain social, political and economic individuality.

Millions of words have been and will continue to be written and spoken on these two themes. Poets, engineers, politicians, statesmen, scientists, theologians and novelists all try their hand, so it might appear useless to add more to the melee. However, a brief recapitulation and analysis of the good, solid stuff that makes up each item

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might be in order. A new look might lead to some small, constructive, new idea.

OUR MASTERY OF SCIENCE

Man has always been a researching animal—that is one of his distinctive characteristics. The utilization of fire, the invention of the wheel, of weaving, of the planting and harvesting of crops represent some of his earliest attempts to improve upon nature. There was no fixed philosophy back of these early gropings, no organized thinking, no planning; only an innate curiosity—a willingness to “try and see,” coupled with a vague understanding of some relations between cause and effect, spiced with a rudimentary ambition. This early inventiveness was by no means scientific. Not until men had collected a great deal of information about the natural world, had perfected their processes of pure reasoning and developed a true thirst for knowledge did they become scientific in the modern sense of the word.

All of you who deal in the teaching of science and mathematics are well aware of the important milestones in the history of science and invention, how hypotheses and theories were evolved and tested, how experimental science began, how ideas grew from mere abstractions to applications and how the whole framework of continuity of thought has been welded together to bring about an overwhelming impact on the world of our personal lives. There is no particular point here in delving into that background; rather we should review some of the results, and the changes they have brought to this somewhat nebulous entity we call civilization.

American Genius for Production

Western civilization undoubtedly grew to its dominant position because of its mastery and use of science and invention. This is a basis for a world revolution which is far more significant than any ideological revolution which has ever occurred. The situation is summed up very neatly by Peter F. Drucker in an article in the *Harper's Magazine* for September, 1949, called “The New Society.” Mr. Drucker states it this way.

“The world revolution of our time is not communism, fascism, the new nationalism of the non-Western peoples, or any of the other ‘isms’ that appear in the headlines; they are the reactions to the basic disturbance, secondary rather than primary. The true world revolution is ‘made in U.S.A.’ and its principle is the mass-production principle. Nothing ever before recorded in the history of man equals in speed, universality, and impact the transformation that modern industrial organization has wrought in the foundations of society in the forty years since Henry Ford developed the mass-production principle to turn out the Model T.”

Mr. Drucker then goes on to point out that the revolution of mass production is not merely a matter of standardized physical operation and machine tools, it is a whole philosophy of organization involving the close integration of the work of specialists, whether they be producing mechanical goods, chemicals, newspapers or personal services. The important aspects of the revolution involve the organized integration of the efforts of teams of people rather than merely the tools with which they work.

The validity of Mr. Drucker's argument can well be seen by comparing the physical standard of living in modern America as compared to other countries of the world who presently live under the older technical regimes, or by a simple comparison of the present with the beginning of this generation in this country. The importance of the development, however, is not confined to mere conveniences and comforts and the ability to do more things in less time. Its impact on civilization is and has been far more dramatic than mere individual gains. Probably most outstanding has been the effectiveness of the United States' participation in two World Wars. In both cases, America came onto the scene late and each time threw the "Sunday punch" which led to victory. The deciding factor was not as much a matter of military genius, or bravery, or even numbers of men, but the tremendous quantity of material "made in U.S.A.," which was thrown into the conflict: the ships, the guns, the trucks, the airplanes, the whole array of armament which simply crushed the enemy by the steam-roller process. The link between industrial productive capacity and the road to victory was demonstrated beyond all shadow of a doubt.

Communication and Travel

The transportation of people, things, and ideas has always been one of the major activities of the human race, bounded only by the limits of the accessible world itself. Automobiles, movies, radio, and finally as a grand climax, the airplane have supplemented and, in many cases have replaced the older means of carrying on this activity. The impact on our way of life has been terrific, not only because of the increased quantity of men, things, and ideas which are transported, but even more because of the great condensation of the time interval that is involved. This gives us more goods and services where and when we want or need them, but it also acts to sharpen up the conflicts which are inherent in our social structure. If the Aztecs of South America had any basic quarrels with the Spaniards, it didn't matter prior to the 16th Century, because neither group knew that the other even existed, and no conflict was possible. But

even the crude means of transportation that Columbus used were instrumental in bringing about an ultimate, devastating conflict between these two peoples. Today a political conflict on the other side of the world may have some direct or indirect effect upon us within a matter of hours. No corner of the earth is now remote from the ways and means of quickly transporting the ideas and the implements of war as well as those of peace. Once, time was a great healer of many ills. Now, there simply is not enough time for it to act in therapeutic capacity.

Agricultural Productivity

In 1787, the year our Constitution was framed, the surplus food produced by 19 farmers in this country went to feed one person residing in a city. In recent average years, 19 people on farms have produced enough food for 56 non-farm people, plus 10 living abroad. Thus in a little more than a century and a half, the ability of the farmer in this country to produce surplus food, over and above his own needs, has increased by over 6000%. The dramatic impact of this trend is well known, resulting in the shift from the strictly agricultural economy to one which is dominated by industry and commerce. The difficult sociological and economic problems which have been occasioned by this change, even though it has been gradual, are certainly matters of common knowledge. My own opinion is that the change has been definitely beneficial looked at from any angle, but there is no gainsaying the fact that it has been the source of many problems in the matrix of conflicts which are so characteristic of modern society.

The Biological Sciences

Public appreciation of the beneficence of the application of the biological sciences, including medicine, seems to be dulled, probably because the success is measured by what doesn't happen rather than what does. In this country we now consider it to be normal and expected that the average child shall be reared with only a modicum of minor ailments, and seldom any really serious disease. It is anticipated that he will grow to adulthood without any serious physical handicaps. Not many generations ago this happy state of affairs was something which was prayed and hoped for but which, on the average, was not really expected to happen. As reflected in rather unimaginative vital statistics, the expectancy of life at birth a few generations ago was of the order of 30 years; now the expectancy of life at birth in this country is over 65 years for women and somewhat less than 65 years for men. The principal gains have been in lessening the hazards of life for infants and adolescents, but now, with the

availability of anti-biotics such as the sulfa drugs, penicillin, etc., the improved knowledge of nutrition, the artificial utilization of hormones, the life of the middle-aged and even the aged has been lengthened. The battle is being seriously joined with the degenerative diseases such as cancer, diabetes, and a series of heart ailments, so that our present really excellent health record should be substantially exceeded in the future.

Obviously this is all highly desirable and of great benefit to those of us who are privileged to be alive. However, even this has its dark side. Over-population in certain spots of the world has always been a problem. The gloomy predictions of the English clergyman, Malthus, that the world must limit its population or soon come to the point of starvation, have had their ins and outs of popularity. Frequently when complete saturation of the population of the world has appeared to be at hand, new techniques of producing food, goods and services have come to raise the practical population limit. Now, however, the effectiveness of medical science in preserving lives is making the problem more and more serious. We are continually thwarting nature in the use of her natural methods of decimating biological species that overpopulate themselves and yet are making no effort, in the world-wide sense, to place any limitations at the source. We cannot long disregard this unbalance of nature without running into some insurmountable problems.

In my opinion the world is already overly populated, in the sociological sense. Mere physical crowding leads to many mass psychological conflicts which can probably only be solved by avoiding them. On the nutritional side, the situation is equally serious. It is quite likely, even now, that two-thirds of the people of the world are malnourished because of lack of sufficient food, and fully one-third, at all times, live on the fringe of actual starvation. Although the use of modern agricultural methods probably can increase the amount of food produced in the world, there is a limit to the productivity of the soil and it would appear from the most recent surveys that we are not far from that limit now. For physical as well as psychological well being, we are probably already at, or beyond, the saturation point for a really decent standard of living. Hence, the very effectiveness of the altruistic work in the application of the biological sciences brings on its own quandary, for we still seem to be holding onto the archaic idea that continuously increasing the population of the world is a virtue in itself. The estimated net increase in population of the world is 70,000 people per day. Since I have begun this talk there are some 500 more mouths to feed than there were when I started. Under the best agricultural conditions it takes about two acres to feed one person. The world is well on its way to running out

of that many usable acres. Unless we soon realistically face the necessity of adequate birth control, civilization may well take on the characteristics of a pack of hungry wolves. There is a chance that we will completely outsmart ourselves with our own cleverness.

Depletion of Resources

The conservation of our natural resources is an old and familiar cry. Yet the average person assumes that because his house is warm now, it will inevitably be that way next week, and that because there is gasoline at a filling station today, it will always be there tomorrow. Perhaps these assumptions are correct but they are certainly not automatically true. Despite great progress in science and industry, unless we can make some really substantial gains in the coming years, future generations of the world will find themselves without the physical wherewithal to carry on the kind of life to which we have become accustomed. Already some of our metals in this country, such as copper and lead, are well on the way to depletion. Perhaps more serious is the still-continuing depletion of the productivity of the soil, both in terms of the essential organic and mineral content and the available topsoil which is being lost because of continuous wind and water erosion. Mineral fuels such as petroleum and coal, though still available in large quantity, are certainly not inexhaustible, and not only individuals but society as a whole must certainly eventually face the problem of what to do about it. We Americans have contributed most to bringing on this problem of depletion of the natural resources, yet we are only about 6%, of the world's population. When the other 94% of the world come to the point, which they so urgently desire, of having a standard of living at least equal to ours, this problem of conserving our resources is going to strike us with a severe and possibly crushing blow. Presumably there are ways of solving the problems of maintaining the wherewithal for human beings to continue their lives in a decent fashion but the answers are certainly not obvious or easy.

INDIVIDUALISM

Man has risen from his former lowly state simply because individuals, from time to time, have stepped out of the routine rut of their existence and attempted to do something that had not been accomplished before. This individuality when teamed with a companion trait, that of human gregariousness, leads to the formation of groups and the resulting group-loyalties: family, tribe, church, labor groups, city, state, nation. Only because of these accretions of individuals around such central, emotional cores has society been able to make advances in the standards of living which can be accomplished by the applications of science by industry. Yet this very mass action itself

inevitably tends to suppress that individuality which is the ultimate wellspring of advance. There is virtue—great virtue—in the rugged individualist—civilization can never move forward without him. Yet by his very nature he doesn't fit the mold of mass-production or mass-government or mass-living. Herein lies the quandary: How can we keep the individuals, as well as the essential groups, all working in one direction without using all their energy and vitality on internal frictions that are always debilitating and occasionally catastrophic? Obviously there is no pat answer, but further analysis of the critical items might point up a design for thought.

The Sense of Security

Both the traits of true individuality and group loyalty probably have evolved in the human nature for a single sound reason—the need for a sense of security. Those who were intent on achieving some modicum of security survived—the others didn't. It is quite common for persons of conservative political temper in this country to greatly decry the tendency of the American public to put paramount importance on social security rather than to take a chance on rugged individual efforts as in the good old pioneer days. The public certainly has the deleterious tendency to look to the government or the labor unions as Santa Claus and to submit to a great deal of regimentation, all in the name of security. Although I decry many of the economic and social trends, I do not believe they are a mark of the decreasing moral and economic fiber in the American people. The truth probably is that the sense of security has been just as important in man for thousands of years as it is at present. Probably one of the greatest contributions of anthropologists has been the demonstration that all men put the greatest importance on maintaining individual control over their means of livelihood. In even the most communistic of the primitive societies man has always kept individual control over his weapons and his tools. The food he raised, the game he killed, even his wives might be considered community property but his fish hook, his spear, his bow and arrow were his and his alone. In the early cattle days in our own country, the open range was common property for all people to use, but the man who stole a horse was guilty of a capital offense.

In modern industrial life, however, man has suddenly come to realize that he no longer has control over the means of his livelihood. He does not own the machine tool at which he works nor the building in which it is housed. Whereas his grandfather, a hardy pioneer who forged boldly into the wilderness, may have seemed a very daring and carefree person, actually grandfather's major yen was for security. He was looking for that distant piece of land which would always

be there and always fruitful; a piece of land which would be his and his alone, where he would finish his days, cared for by his children and grandchildren and where he would be buried for his last long rest. This was all very important—it was the essence of security. His grandson finds himself working in a factory for an hourly wage, and, to a considerable degree, his very existence depends upon the whims of an employer or on the unpredictable trends of economic life. Just as his grandfather did, it is very natural indeed that he should seek security by whatever means he can. The means at hand, and the only ones which seem to make sense to him, are political action either through normal governmental channels or through union organization. Though many of the things that are transpiring at present may be socially undesirable to a degree, they should be no means be taken as evidence of the weakening of the moral fiber of the human race. Until there is a full comprehension on the part of the leaders, as well as the people, of the universality and importance of this sense of security, I seriously doubt if we will be able to arrive at reasonable solution of a number of our social problems.

The Possibility of War

In some quarters it is popular at the moment to expound on a line of pessimism which says that another world war is inevitable and that because of the effectiveness of modern weapons it will be completely destructive and will wipe out the human race, or at least civilization, and so what is the use anyway? Though the lethality of modern weapons and those that are in development can hardly be overemphasized, there is no justification for taking that gloomy a view. Another full-fledged world war would, without doubt, be truly catastrophic. Possible physical destruction would completely overshadow that of World War II. Undoubtedly millions would lose their lives, human relations would degenerate, suffering might well exceed any that we have ever known. Civilization would receive a very serious setback, but it would not be destroyed. Time and again it has been demonstrated that human society is made of very tough material and that it does not destroy easily.

Let it not be thought that I am not fully aware of the seriousness of another world war. When civilization does become fairly reasonable and reasonably peaceful, such conflicts will have become unthinkable and unspeakable. The major task of the world today is to avoid such a war if at all possible. Let no one underrate its potential seriousness but also let him not be so pessimistic as to assume that there is no hope and no future for the world.

Often it appears that because of our perpetual conflicts, individual and group loyalties will always call for the battle of man against man

and group against group. We seem never to be really unified until we are in danger, and battling in a common cause. A real "moral equivalent of war" apparently has never been found. At times it appears that the only way to avoid conflict between us and the Russian nation would be to have an invasion of men from Mars so that we would band together against the common enemy. Admitting that competition by individuals and groups is probably the heart of our existence and advancement, no one has really explained why, even when engendered by a sense of insecurity and by pride and prejudices, the competitive aspect repeatedly gets out of hand to the extent of destruction combat between nations. From the viewpoint of common sense, it is utterly silly, but there it is, and is not readily explained away. It is of course trite to say that this is a major social problem of our generation, but it will still bear repeating. Any possibility of solution should be grasped and examined to the full.

The Socialized State

The present popular appeal of the idea of the "welfare state" in this country is, I believe, generally recognized to be but another step towards the completely socialized state. The socialized state, whether under the name of communism or any other is, of course, by no means new in history. Communistic societies were the rule rather than the exception among primitive people. Among small homogeneous groups in a simple economy it was probably not only a workable but perhaps the best arrangement. Without going into any of the many possible points of argument, however, I do feel that it is in order for me to express the very firm opinion that the truly socialized state is completely unworkable for modern society. The basic reason is that socialism, to be really workable, must be so complete that individuality is thoroughly suppressed. If any individual happens to step out of line with the rules and mores of the socialistic state, he must be brought back into line, or eliminated, or the whole delicately-balanced structure will start to collapse. The present Russian nation should be enough of an example of the end results to be completely convincing to any outsider. Complete socialism, if carried to its logical conclusions, means that we must fall into the ant hill existence. It is conceivable that the ant life would be simpler but, in my opinion, it could hardly be worth-while, and certainly not much fun.

THE ELEMENTS OF SOLUTION

The above hit-and-run treatment of the factors which enter into our present quandary does not, by itself point the way to our getting out of it. Progress of civilization is certainly only a bootstrap pulling proposition at the best, and thousands have searched for the simple

answer but none have found them. The above list of quandary-producing items is really very short. Anyone can think of dozens of others. The ones I have discussed, however, do seem to me to be those which are of greatest importance. If we can find the means of resolving the undesirable types of conflicts implied in their existence, I think we would be well on our way to the brave new world. I am certainly not going to be so presumptuous as to indicate that I know the way out but, here again, a delineation of the possible channels through which solution might be sought may be worthy of consideration.

The Role of Democracy

I am quite convinced, not only for emotional reasons but because the arguments appear very sound, that the real solution will ultimately be bound in continuation along the paths of democracy. Democracy is a term which is much bandied about and also much maltreated in these days, so it first needs to be defined. The democracy which I am speaking of is that which was most aptly and most completely defined by Abraham Lincoln as the "Government of the people, by the people and for the people." This definition, by statement and by implication, embraces, in my opinion, a quite ample delineation of the essentials of democracy for all time to come. Because of the presumed temporary effectiveness of dictators, there are those who believe that, as life becomes more complicated, democracy becomes less effective and that totalitarianism, with the big boss on top, is the only way that we will arrive at a stable civilization. It would appear that history would give sufficient examples to show that dictatorships or a totalitarian state of any sort are not only cruel but ineffective and often short-lived. However, the appeal of the effectiveness of an efficient industrial management is so strong that it is often carried over, by analogy, as the ideal for the political unit of the state or the nation. It is my opinion, however, that the very complexity of our modern affairs is the thing which makes it necessary that the Government shall be of, by and for the people. Since the world does not have and never did have individual supermen who were so all-wise or of such infinite ability that they could individually handle all affairs of civilization, it becomes necessary that effective and true collaboration and integration of the efforts of the people is required. People being the way they are, you only arrive at this type of collaboration if the government truly reflects and represents them, their needs and their wishes. No matter how angry and disgusted I become at times at the trends and the vicissitudes of political democracy, and at the debilitating effects of a presently advancing bureaucracy, it is still my firm conviction that it is not only the

soundest but the only route along which civilization can advance. The democratic pattern which is ultimately evolved may have many phases and aspects which would seem strange to us, but still the elements of "of, by and for the people" must, and undoubtedly will be there. Further, if we are to have a world which will remain in peace, world-wide collaboration and hence, world-wide democracy is an absolute essential. That, of course, is a basic bone of contention between us and the Russian state at the present time. Whether the necessary world-wide conversion can come by persuasion and demonstration rather than war, only history will tell.

The Time Element

By the time we emerge from early childhood, the pattern of our thoughts and our emotions are fairly well fixed. We continue gaining new knowledge for years to come but the genes and our environment have left their permanent mark by this time, so our individual and group responses, particularly in the field of emotion, is quite predictable and, on the average, changes but little. Modern civilization is, in essence, an experiment in the business of two billion people living together on one small planet, which is proving to be quite confining. The raw material of that experiment is people, and, since each generation becomes fixed in its characteristics quite early in life, we can only really perform about one good experiment per generation. We have only been attempting this business of living together for a few hundred generations, so we have only been able to perform a few hundred experiments. Considering the complexity of the task, it seems to me that we have done very well indeed. Many a relatively simple problem in physics or chemistry takes many times a few hundred experiments to arrive at a successful solution. Hence, if we could look at ourselves objectively, we would probably conclude that, everything considered, we are not doing too badly. Naturally, we would like to see the experiment completely successful in our own generation. That is a worthy emotional reaction but it is not a true measure of the success or failure of the work.

In the older days, before science really began to make itself effective in the world, physical changes in the way of life came very slowly and the needs for social change were correspondingly slow. Life in medieval Europe was probably very dull, but life did move slowly on its more or less tranquil way, and there was always ample time for another generation to come along and adapt itself to any changes that were necessary.

At present, however, important changes in the framework of living occur not once per generation but they come by the year and sometimes, it seems almost by the hour. The present inhabitants, an en-

semble of two billion people, are continually thrown into a state of emotional, political and economic indigestion. It is not just change itself that makes the problem difficult, it is the *rate* of change. Our capacity for adaptability, unfortunately, is not great enough to handle the situation. Although the classicists believe that the ancient Greeks were a superior race, the like of which has never been seen before nor since, I am not one who believes that we have lost ground intellectually or emotionally in the last few generations. We have essentially the same capabilities—are about the same breed of animals. Our fund of information is infinitely larger than it has ever been before and in view of the circumstances our decisions and actions are probably about as intelligent as they have ever been. The complications of the job that we have thrust upon ourselves by the rapid transformation of the physical world are such that any one generation, with its preset mental cast, cannot solve them as rapidly as they come. Our performance may appear to be poor but it is no cause for real despair. The new generation has nearly always surprised the older one with its ability to get on in the world and if this happens often enough things will not turn out so badly after all.

Education

It is quite popular, though unsportsmanlike, for speakers to lay out the problems of civilization, as I have just attempted to do in a quite elementary fashion, and then evade the issue by saying that the solutions lie directly in the lap of the educational system. I can do no better, because I believe that that is true. I am speaking, however, of education in its broadest sense, not merely the formal courses of the classrooms, but of the whole ensemble of intellectual, political and social pursuits which mold the actions (even if not the minds) of adults as well as children.

Though I was engaged for a number of years in teaching endeavors myself, I never arrived at any firm conclusions as to the best or even a good way of leading the new generation to acquiring knowledge and understanding. I have found, however, that the first requisite of even moderate success in the field is to have the objective quite clearly defined in the minds of both the teacher and the pupil. In the teaching of science, before it arrives at the truly professional level, it seems to me that the acquisition of bits of knowledge about the physical world and what makes it tick, should merely be a secondary objective. In the field of general education, particularly, it would appear that the prime objective of the teaching of physical sciences should be to inculcate a real *understanding* of the physical world as contrasted to the mere acquisition of facts. This understanding, as I perceive it, would be that the world is put together

and operates on certain unalterable principles which we call natural laws and that for every cause there is an effect, and vice versa. The objective of research and the subsequent teaching is to determine these relations between cause and effect and to realize that these things are true and unchanging. If the mass public can come to really believe that, a great deal of the mumbo-jumbo of the modern world would be automatically removed.

Extending this basic understanding of cause and effect to the social world, the educated public would begin to realize and comprehend that human beings themselves, individually and en masse, operate in a cause-and-effect framework, just as do clocks and levers, radios and airplanes. Our knowledge of cause and effect in dealing with people, whether in religion, economics or politics, is certainly meager. It is all inexorably wrapped with an emotional pattern but mere complexities do not change the fact that there is some reason for everything that happens, even with people. Determining reasons is the first step towards achieving a remedy. Far too much effort is spent in exhorting people and telling them how they ought to be rather than in finding out how they really are. It is my opinion that a continuing, thorough and valid teaching of science in the school room now will inevitably lead to a much more objective attitude on the part of people toward themselves and toward each other in the future. From this should come a basis of understanding, perhaps even a little sympathy, and slowly the solution of the basically social problems will begin to take shape. Thus will eventually arise the reasonably intelligent electorate which is necessary and sufficient for effective democracy. This is certainly not a very definitive suggestion but perhaps it can help at least one person, in laying out a teaching program which will be more useful to the coming generation.

RECAPITULATION

By way of recapitulation: I have attempted to point out that civilization is probably in its most serious quandary in history because of the inherent conflicts which arise between its mastery of the physical world and the modification in our individual thoughts and actions which this appears to call for. Since science has moved very rapidly in recent years, the world's sociological structure gets out of phase, and the situation is probably becoming progressively more serious. If the world were moving more slowly, time would help greatly in solving our problems, but since we cannot have time on our side we must look more than ever to education as the means of keeping civilization on the beam. The democratic state appears to be the only framework which can possibly furnish the structure for permanent solutions. Education, particularly at the general education

level, should put more emphasis upon the objectives we are trying to achieve, and on the basic pattern of the workings of nature, including people, rather than centering all attention on mere facts and figures. Only thus will we have the necessary and sufficient intelligent electorate. The world will always operate more on emotion than it does on logic but if we recognize that, we can do something about shaping the mass emotions into workable channels.

I have presented you with no teaching methods. I have given you no solution to any problem. All I have done has been to make a feeble attempt to analyze the basic problems which we recognize to be universal and serious. Hence, you may well say, my efforts in exposition on these topics represent no progress at all. You may very well be right. However, considerable experience in research, backed by looking over the shoulders of many others, has shown me that when a research problem is well analyzed it is half-way on the path toward solution. It is my firm conviction that civilization is an experiment—a problem in research. Whether or not my analysis has been correct and, hence, helpful, I must leave to you to judge.

INSTRUCTIONAL MATERIALS

The University of Oregon Instructional Materials Laboratory announces the re-establishment of its *Curriculum Bulletin* series with the release of five new numbers of interest to teachers of Science.

- No. 57 *Instructional Aids to Learning*. 47p. 50¢. (A comprehensive list of bibliographies and sources of Audio-visual Aids brought up to date July, 1949.)
- 58 *Free and Inexpensive Teaching Materials*. 22p. 25¢. (A list of 200 firms and agencies that distribute free and inexpensive educational materials of value in most subject areas.)
- 60 *Education for Paradise Valley*. 71p. 50¢ (An "ideal" plan for an educational program, prepared by a class of experienced teachers and administrators.)
- 61 *Curriculum Foundations for Paradise Valley*. 49p. 40¢. (An analysis of basic factors—sociological, philosophical and psychological—to be considered in planning a curriculum for modern education.)
- 62 *Curriculum Plan for Utopian Schools*. 53p. 45¢. (Another "ideal" plan with special emphasis on the curriculum and its organization.)

Earlier numbers of the *Curriculum Bulletin* that are still available and of interest to teachers of Science are listed below:

- No. 7 *High School Science Program*. 25p. 30¢.
- 15 *Planning and Teaching Curriculum Units*. 18 p. 25¢.

Inquiries and orders should be directed to: Instructional Materials Laboratory, School of Education, University of Oregon, Eugene.

Why is the Central Association of Science and Mathematics Teachers unique among teachers organizations? Read the history of the organization in *A Half Century of Teaching Science and Mathematics*.

AN ADAPTATION OF THE B & L MICROPROJECTOR

HOWARD H. HILLEMANN

Oregon State College, Corvallis, Oregon

In the projection of slides bearing embryological serial sections, it is very desirable to have the use of a mechanical stage. Since the Bausch and Lomb microprojector comes unequipped for the mechanical movement of slides, several additions and modifications were made.

The slide stage already attached to the projector is much too small to accommodate either a standard mechanical stage or a slide when projected from one end to the other. This slide stage was therefore replaced by one of larger dimensions, $4\frac{1}{2}'' \times 5''$, approximating that of ordinary laboratory microscopes. It was drilled with the same size hole for the beam of light and tapped to be secured by the same screws which held the original. It was also found necessary to notch this new platform to accommodate the vertical support. This newer platform

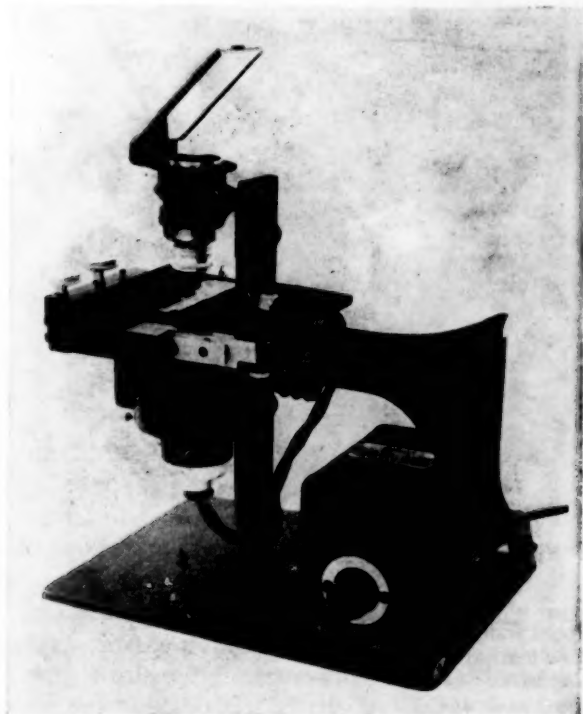


FIG. 1. Horizontal projection.

was made thicker ($\frac{5}{16}$ ") than the original in order to fit the recess in the type of detachable mechanical stage available for ordinary microscopes. It was necessary to shorten the spring-loaded slide-retaining bar of the mechanical stage to a length equal to the width of an ordinary slide, to prevent its interference with the vertical support of the projector.

After this mechanical stage was added along with the replacement stage, the tripod microprojector was found to lack stability when projecting horizontally. This difficulty was obviated by the addition of a rectangular base, approximately 7" \times 10". Each of the three legs was tapped and secured to the base with flush screws from below.

As a further correction for instability, particularly when the instrument is used to project vertically downward, the transformer was also secured with four screws to the base and close to the twin legs. An added advantage is the fact that the transformer is incorporated into the structure of what is now a single instrument. The composite instrument is shown in Figures 1 and 2.

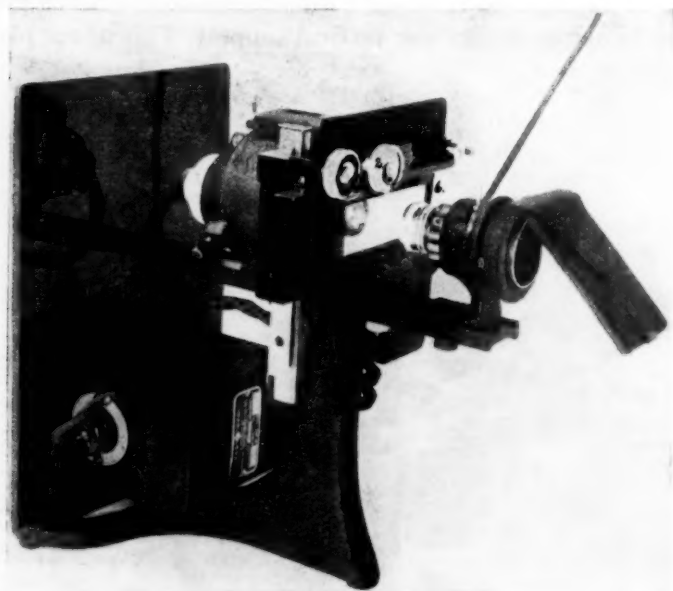


FIG. 2. Vertical projection.

EXPLANATION OF FIGS. 1 AND 2

1. replacement slide stage
2. detachable mechanical stage
3. stabilizing base
4. transformer mounted
5. notch to accommodate vertical support
6. shortened slide-retaining bar

Materials for the replacement stage and base consist of bakelite, but any other rigid and durable material would suffice.

The workmanship together with the bakelite was obtained for \$17.50 (Silge & Kuhne, 153 Kearny St., San Francisco 8, California). The expense of modification was provided by the Department of Zoology, Oregon State College.

NEW EDITORS AT WORK

JULIUS SUMNER MILLER

Our new editor in charge of Science Demonstrations is Julius Sumner Miller, professor of physics at Dillard University, New Orleans. After graduation from Boston University in 1932 he remained there the following year and received the M.A. degree in theoretical physics. He held a fellowship for two years at the University of Idaho where he received an M.S. degree in engineering physics. Later he taught and studied at the University of Oklahoma. During World War II he was with the Signal Corps at Fenn College Cleveland. He then taught for one year at Chapman College, Los Angeles. Other teaching positions during summer sessions include Ohio Wesleyan University, The University of Redlands, and the University of California for three consecutive summers. He has written for many of the leading journals in the fields of science and mathematics. His hobbies are gardening, ornamental leather tooling, metal working, and canoeing.

GEORGE S. FICHTER

In zoology, to replace Mr. Wright who resigned because his interests are now largely in other fields, we present Mr. George S. Fichter of Miami University, Oxford Ohio. Mr. Fichter received his Bachelor of Arts degree from Miami with a major in zoology and special fields of botany and geology. Later he received an M.S. degree in entomology from North Carolina State College and did some work toward a Ph.D at the University of North Carolina. He is a member of Phi Kappa Phi and of Sigma Xi. Although he has a record of only about two years in the field as a writer his numerous papers published in *Herpetologica*, *Endomological News*, *Wild Life in North Carolina*, and other journals of science establish his merit. His principal interest is in the popularization of science for the layman. He will work with Professor Potzger and Mr. McMenamin to continue and improve our publications in the biological field and give aid to the teachers in these branches of science.

EINSTEIN'S PROOF

$$\text{OF } E=mc^2$$

WALTER H. CARNAHAN

Purdue University, Lafayette, Indiana

Einstein's formula for the equivalence of mass and energy is probably more familiar to the man in the street than any other formula in existence. It has been reproduced in color on the covers of popular magazines, and it has been repeated many times in the pages of newspapers. Having heard that only a dozen men in the world are capable of understanding Einstein's Theory of Relativity, the reader usually glances at the simple formula $E=mc^2$, says "I am not one of the dozen," and hunts up the comic page. However, when one reads Einstein's development leading to the assertion of the equivalence of mass and energy, he is impressed by its essential simplicity.

Einstein makes use of two laws of elementary physics.

Law I. *Momentum equals the product of the mass of a particle times its velocity.*

Law II. *Kinetic energy equals half the product of the mass of a particle times the square of its velocity.*

Let M_o represent the momentum of a particle, v its velocity, m_a its mass, and E its kinetic energy.

By Law I,

$$M_o = m_a v. \quad (1)$$

By Law II,

$$E = \frac{1}{2} m_a v^2. \quad (2)$$

Consequently,

$$M_o = \frac{2E}{v}. \quad (3)$$

Radiation exerts a pressure, and light falling on an absorbing body impresses energy. The momentum impressed on an absorbing body by a flash of light is

$$M_o = \frac{E}{c}. \quad (4)$$

Here v of Equation (3) is replaced by c , the velocity of light. We have E rather than $2E$ of Equation (3) because half of the energy is impressed on the emitting source. "For every action there is an equal

and opposite reaction." We may account for the total energy involved with the equation

$$\frac{E}{c} (\rightarrow) + \frac{E}{c} (\leftarrow) = \frac{2E}{c} = M_0. \quad (5)$$

Suppose there is a hollow tube with equal bodies *A* and *B* at the ends, but *A* has an excess of energy over *B* (say, heat sufficient to produce light), and there is a reflector at *A* to send radiation to *B*. When the energy is radiated, *A* experiences a recoil E/c . Then the whole tube whose total mass is *M* acquires a velocity *v* directed backwards and determined by the equation

$$Mv = \frac{E}{c}. \quad (6)$$

This equation can be written

$$v = \frac{E}{Mc}. \quad (7)$$

The motion of the system continues while the flash of light travels from *A* to *B*, then *B* receives the blow forwards and the system comes to rest. The displacement *x* of the system while the flash is traveling during time *t* is

$$x = vt. \quad (8)$$

This is the usual distance-rate-time relation.
We now have

$$x = vt = \frac{Et}{Mc} \quad (9)$$

from above.

Here E/Mc is substituted for *v*.

The time
$$t = \frac{l}{c}. \quad (10)$$

l is the distance from *A* to *B*, that is, from the original position of *A* to the final position of *B*. This is again the familiar distance-rate-time relation. Hence,

$$x = \frac{El}{Mc^2}. \quad (11)$$

l/c is substituted for *t*.

Now, suppose the bodies *A* and *B*, for the moment assumed to be

equal, to be interchanged without any influence external to the system of which they are a part (say, by men inside the tube). Under this condition, the tube undergoes no displacement except the one displacement x due to the flash of light. If we assume that nothing material moved from A to B and that the interchange of A and B is an interchange of bodies that are still equal and made by agents that are equal, then there seems to be no way to account for the displacement of the system the distance x . We may look at it this way: Something was done to the material system which resulted in its being moved. If the original material internal situation is restored, the original physical arrangement should also be restored in all respects as it was. Einstein says that the only way to escape the apparent contradiction is to assume that after the flash, B has a mass greater by m than A because of the radiation energy which it has received. This assumption means that during the interchange of A and B , symmetry is not maintained, the effect of the interchange being to transfer mass m a distance l . Hence, the whole system must at the same time be displaced a distance x in the opposite direction.

This hypothetical interchange of A and B having served its purpose, we now return to the situation immediately following the flash of light. Final steps in the analysis are based, not upon the hypothetical interchange of A and B , but upon the situation resulting from the flash of light.

The total momentum, consisting of that of the tube $M(x/t)$ and that of the transferred mass $-m(l/t)$, is 0.

This is Law I with x/t and l/t representing the velocities.

That is,

$$M\left(\frac{x}{t}\right) - m\left(\frac{l}{t}\right) = 0. \quad (12)$$

Whence,

$$x = \frac{m}{M} l. \quad (13)$$

Now, the distance through which the system is moved as a result of the energy emitted at A must be equal to the distance through which the system is moved as a result of the hypothetical interchange of A and B .

Hence,

$$x = \frac{ml}{M} = \frac{El}{Mc^2}. \quad (14)$$

Therefore,

$$E = mc^2. \quad (15)$$

NEW DEVELOPMENTS IN CHEMISTRY OF INTEREST TO HIGH SCHOOL TEACHERS

WILLIAM J. ARGERSINGER, JR.

The University of Kansas, Lawrence, Kan.

Any article under the title chosen must necessarily be quite arbitrarily selective, since obviously there are new developments of all kinds appearing almost from day to day. The alert high school teacher, like all other alert teachers, is responsive to every such development to some extent, but rarely is in a position to take good advantage of any large number. Some events, such as the recent Nobel Prize Award (1) to the American chemist, Professor William Giauque, may be utilized immediately in class room work, furnishing interest and inspiration for the student and suggesting an obvious study project for the teacher. Similarly, the recent action of the International Union of Chemistry (2) revising names of some of the older elements and approving names of the newer ones, is useful in bringing out a number of aspects of chemistry and scientific study in general—the universal, world-wide cooperation of chemists; the need and use of common names and terms; and the continual growth and refinement of knowledge. On the other hand, the research of the last few years in the study of helium at very low temperatures (3), for example, although extremely important in the development of theoretical chemistry, almost certainly is not applicable in the general high school chemistry course.

From the wealth of new technical developments in chemistry one may choose a small number of potential usefulness to the general chemistry teacher. Among these is the mushroom growth of processes involving ion exchange phenomena, that is, the interchange of ions between liquid solutions and certain solid materials (4). Within the last ten years or so, this field has grown from simple water softening only, to include such applications as the separation of fission residues or rare earth compounds, the complete demineralization of water, the preparation of industrial products such as sugar and syrups, the refining of petroleum, the treatment of milk products, and the recovery and purification of vitamins and other substances of physiological interest. This growth has been made possible primarily by the production of tailor-made exchange materials such as the substituted polystyrene resins, which have specific exchange properties required for given applications. As a matter of fact, the art of ion exchange outstripped the science to some extent, as often happens, and it is only within the last three or four years that a nearly complete understanding of the mechanisms (both chemical and physical) involved in

the ion exchange process has been built up on the careful research of a number of investigators in the field.

A second technical development which should be considered is that in the field of isotope research and application (5). The research in nuclear physics which led during the war to the atomic bomb, led also to the production of relatively abundant supplies of many isotopes, either from separation of the fission residues from nuclear reactors, or from neutron bombardment of suitable targets in the reactors. These isotopes are now available from Oak Ridge to responsible scientists and other agencies for research and therapeutic use. The research applications of chemical interest are primarily in tracer experiments (6), in which an isotope of a given element, usually radioactive but not necessarily so, provides a means of identification of that element as it proceeds through the steps of a chemical reaction. In this manner the mechanism of the process may be studied. For example, a great deal of work has been done to elucidate the photosynthesis process (7), using the radioactive carbon isotopes of mass 11 and 14 to prepare carbon dioxide which is then taken up by plants. The products of photosynthesis in the plants are isolated and analyzed for the radioactive carbon to determine the principal intermediates in the process. In other research investigations radioactive isotopes provide a fairly simple and accurate means of analysis for the elements, or compounds of the elements, concerned in the process under study; for example, the study of diffusion systems, meteorite composition (8), adsorption processes, and ion exchange equilibria has been facilitated by the use of radioactive isotopes in analysis.

In medicine, the same techniques have been used in research, and in addition direct therapeutic use of certain newly available isotopes has already been made. Chief among these is the well-publicized "atomic cocktail" (9), a solution containing radioactive iodine of mass 131, which has been fed to selected patients and found to be highly beneficial. Very recently newspapers announced the successful use of thorium X, an isotope of radium, in treatment of cancer of the skin.

Closely related to the developments in radiochemistry is the discovery of new elements, and the filling up of the periodic table as far as Element 96. While this is not to be considered a new development, extending as it does back at least to 1937 in the case of certain elements, it is nevertheless of great interest to the high school chemistry teacher who is now able to present a unified complete system of the elements to his students. Furthermore, the stepwise experimental investigation of the properties of a new element, such as astatine or one of the trans-uranium elements, furnishes an interesting and illuminating study in the general aims and techniques of scientific re-

search (10). Every chemistry teacher can use this material to advantage in developing in his students an understanding of and feeling for the scientific method.

The last several years have seen important developments in the teaching of chemistry as well as in the field of chemistry itself (11). While the trends in pedagogical methods in chemistry may be more apparent at the college level, they exist in high school courses as well. More important, the high school teacher will want to know how best to prepare his students for further chemistry study in college, and presumably will fit his methods, to a reasonable extent, to those used in college chemistry courses.

Chief among the new trends is the increasing emphasis on a logical development of general chemical knowledge from first principles, rather than the more or less disconnected hodgepodge of experimental results, incorrect hypotheses which later must be discarded, and misleading theories adopted entirely because of their simplicity, such as too often marked general chemistry courses in the past. The study of first principles means an increased *but not exclusive* emphasis on molecular and atomic—even nuclear—structure, and the application of physical concepts to establish the necessary consequences of these structures, the physical and chemical properties of the elements and compounds, and the conditions under which they react one with another. The approach to such a logical development may be either chronological or otherwise; examples of both may be found in recently published general chemistry texts (12).

The modified historical approach, the "forward," or "outside to inside" method, as it has been called, seems in many ways the best. Here the student is not at the very first overcome by a flood of important but seemingly unfounded ideas on the structure of atoms and molecules, even before he has any reason to believe such entities exist. Neither is he treated to a precise chronological recitation of facts and theories as they were discovered or propounded and then revised or even discarded. Rather he follows to some extent the same path that the pioneer investigators worked out, *with this difference*—that he need not make the mistakes they did. He is not first taught and then "untaught" the ideas of Berthollet and Thomson on heats of reaction and chemical affinity. The student goes through the reasoning of Arrhenius on electrolytes, but profits from experimental knowledge not available to the great Swedish chemist, and evolves a reasonably complete and correct picture of the behavior of both strong and weak electrolytes. It will not be necessary for him later to "unlearn" such things as partial dissociation of sodium chloride in dilute aqueous solutions; he will advance easily into the finer points of the Debye-Hückel theory without any abrupt transition from,

or denial of, the principles of the Arrhenius Theory. In every phase of the study of chemistry, the teacher and his text can develop this process, modifying to some degree the strict chronological order of events to obtain a coherent and logical background for the theories we now hold.

The relationship between the structure to properties emphasis and the modified historical approach is easily established in the development of the atomic theory (13). It is possible to construct a logical pattern, extending back to the Greeks, leading up to our modern knowledge of the structure of the atom, without considering in detail all the descriptive chemistry which to be sure aided historically in the development. The basic structure and properties of the atom having once been established in this reasonable manner, the application of a few simple fundamental physical concepts then leads directly to predictions of most of the varied properties of substances and conditions of chemical reaction. The student need not "memorize" the Electromotive Force Series, for example; rather, he discovers it for himself as a necessary consequence of the structure of the metallic atoms. Complex ions do not constitute a new isolated topic for him, because they are just other examples of types of chemical bonding with which he is already familiar. A student of today quite probably should do a much better job of predicting properties, compounds and even sources of a missing element than did Mendeléeff himself.

The alternative approach, the complete "inside to outside" method, neglects a great part of the historical background of modern chemical knowledge. The student is given *ad hoc* the results, in the form of theories of structure from which, of course, he may derive properties and reaction conditions, but the reasons for the structural theories are too often lacking. He fails to see and understand the scientific method in operation, and his knowledge of chemistry, although correct, is based on a picture of the microcosm accepted almost entirely on faith. In the hands of very good teachers this approach may produce excellent results, but even so it seems inherently less satisfying than the modified historical method.

A final development which should be of great interest to high school teachers especially is the Atomic Energy Commission Fellowship Program. In an attempt to stimulate interest in science and scientific careers among qualified students a large number of fellowships have been made available. While these are at the college graduate and postgraduate level, their effect should be felt in high schools, where the training must begin. Several fellowship programs for entering college students also have long been in operation, supported usually by private sources (14). The interested good student can look forward to this support and prepare himself the better for a profes-

sional career in science, even though his own economic means may be very limited. It may be presumed that such support will be even more widespread if any type of National Science Legislation is passed by Congress. In any case, such developments may be used to arouse and increase interest in science among capable high school students. In the last analysis, perhaps the principal function of the high school science teacher is the development of this interest—once really awakened, the student will learn eagerly and rapidly the tools and methods of his chosen profession.

REFERENCES

These references are not intended to be complete but merely serve to provide a few typical articles or books which should be available to the high school teacher without great difficulty.

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200 POUNDS OF METALLIC URANIUM CAN SOON BE PURCHASED

Uranium, the silver-colored metal of atomic bomb fame, can soon be purchased under AEC license through normal trade channels, the Atomic Energy Commission has announced.

Uranium in metallic form was a laboratory curiosity in 1941, when the total amount available in this country was less than half a pound. The 200 pounds that has just been authorized for sale is within the limits of the two to 200 pounds estimated as the critical size necessary for an atom bomb, but there is no chance it can be used for a bomb.

This uranium metal, however, will not have the content of fissionable isotope 235 required for atomic bombs. It can be used for research such as work with electron microscopes.

Some of the first uranium metal produced in this country was made by Westinghouse at a cost of \$1,000 per pound. Price of the uranium metal to be sold by Mallinckrodt Chemical Works will be approximately \$50 per pound.

Uranium metal was first isolated about a century ago, but it was so rare that many of its properties were not known with accuracy until 1941. Production rate at the end of 1942 was about one ton a day in metal.

A NEW PLAN FOR SUPPLEMENTARY READING MATERIALS IN CHEMISTRY*

HERBERT R. SMITH

Milton College, Milton, Wis.

Some subjects in our educational curricula are practically static. Their motto in ancient language might well be, "that which has been done is that which shall be done." The science subjects are not so but grow by research into nature's secrets. Chemistry, like all other sciences, grows fast with the result that our textbooks have become too voluminous with the addition of new subject matter while hanging on to all the old ideas. The problem has been growing with increasing rapidity but little is done about the situation. It is not possible to give class attention to all topics in the texts during the first year chemistry or in general college chemistry. It is expected that teachers will select those topics most appropriate for pupils and leave the remainder for a possible reading by them. The increased cost of textbooks, however, is one good reason why we should find some way to lessen their cost. Our pupils are growing round-shouldered and weary carrying the heavy texts, and no doubt they agree with Solomon, saying, "Of making many books there is no end; and much study is a weariness of the flesh."

It is time to leave descriptive details to supplementary reading and boil down our texts to methods of thinking; the application of properties and principles in chemistry to the solution of the daily problems that confront all of us without regard to our vocation or avocation. Too often we are not aware of a problem by our not knowing how to look for facts which govern the situation. Facts themselves do not constitute an education. They are only the tools which are applied to a problem to solve it. Our pupils need to know how to use these tools. Without this knowledge the possession of unlimited facts is of no value, only a weary burden. But if our pupils are trained to look for and use facts in the solution of problems, they are educated. They will be able to acquire facts as they need them and their education will continue throughout a joyful life.

It has been considered a good plan to append to a text a list of books as supplementary reading. It is a *laissez faire* plan which is supposed to be good for a liberty-loving people. But the average pupil uses only the "lazy" part of the plan and does not go *far* with the reading. The writer improved the plan by giving page references to books with each topic in a text published in 1928, but such a list can not be efficiently administered for these reasons:

* Read before the Chemistry section of the Central Association of Science and Mathematics Teachers, Chicago, November 25, 1949.

I. A very small number of pupils will voluntarily hunt out a book to do the reading.

II. If the teacher urges the reading so that a considerable number of pupils respond, how can a single book serve more than a few pupils?

III. The cost of sufficient books is large and they are not obtainable by the smaller schools. We make the statement advisedly that the usual list of reading books in chemistry is not worth the price paid, for they cannot and will not be used efficiently.

IV. Principals and superintendents have filled up the pupil time with so much extracurricular activity that many of them do not find time for proper study of regular subjects. How can they find time for supplementary study?

A different approach, practically perfected by the writer, is as follows: It is an increasing practice for manufacturers to prepare a printed booklet telling how their products are manufactured. They are written for the layman consumer of his goods and are considered as advertising. Frequently some teacher will suggest that pupils may write manufacturers for details of their operations. The U. S. Steel Corporation says in the preface of its booklet that thousands of such requests are received each year, and that it is their hope that the book may be acceptable as supplementary reading material in the schools. Enough firms are now following this plan so that ample supplementary reading in chemistry is now available with the only cost of asking for it. The writer has prepared an evaluated list of fifty such booklets which pertain to most of the topics in chemistry texts. Their advantages are:

I. They are fully authentic, being written by a capable person on the company staff.

II. They are far superior to our texts in detail for they are not limited in space. Their illustrations may occupy half the space, and are very clear-cut halftones and drawings.

III. They can be obtained in number sufficient for a class so that each pupil has a copy. This makes it possible for a 100% spread of the class in the reading with possible means of enforcing a thorough reading. No firm has refused to send enough copies for the whole class.

IV. They can be assigned as a definite lesson with positive directions on how to prepare it.

V. The booklets are carefully preserved as school property for use in subsequent classes until they are worn out.

VI. If the request is made, promising careful use, it is seen by the firm that a copy in the hands of a young person soon to be a purchaser, will bring a more productive return than a copy distributed by any other means.

VII. They are more efficient than field trips made to the actual factory, for there is a great saving in time, expense with no hazards involved. No missed work in other classes. No distractions in attention.

VIII. The booklet for every pupil is far superior to the report to the class by a single pupil. Here one person does the work and the others hardly listen, so only one person gets real benefit. Some teachers favor the report method for it takes up the class time with little effort on their part.

A MESSAGE FROM THE EDITOR OF SCIENCE DEMONSTRATIONS

On the invitation of our Editor-in-Chief, Dr. Glen W. Warner, I have undertaken the direction of this Department. As a preamble I might profitably use a phrase from that beautiful dedicatory preface which Andrade makes to Lord Rutherford: "I fear that it will avail me little to plead the largeness of my design as an excuse for an imperfect execution of its particulars." Our intention in this Department is to bring to teachers of science at all levels an array of demonstration experiments. Indeed, there is no better instructional device than a demonstration, and most teachers have in their repertoire a goodly number of excellent experiments which are highly effective as class demonstrations.

It should be obvious that I cannot run this Department alone. Indeed, it is *your* Department, just as the Journal is your Journal, and its success depends on our joint and combined efforts. Accordingly, I beg you all to send me your write-ups of demonstrations which *you* find instructionally useful. They do not have to be elaborate affairs. The simpler the better. I will edit them, if they need it, and publish them over your name. Perhaps your students have ideas. Urge them to write me, too.

Your contributions will promote the welfare of the Journal by increasing its usefulness to teachers, and teachers will become more effective in their instruction.

Please let me hear from you.

Very sincerely yours,
JULIUS SUMNER MILLER
Dillard University
New Orleans 19, Louisiana

Virgin heifers and barren cows were induced to give milk by burying tablets of the synthetic female hormone diethylstilbestrol under their skins.

THE SEMI-MICRO APPROACH IN A FIRST CHEMISTRY LABORATORY

FOSTER H. HOFF¹ AND ALFRED S. BROWN

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Much interest and lively debate has been stimulated by recent evaluations of the effectiveness of laboratory work in introductory chemistry courses. The traditional "Chemistry Laboratory" has been challenged as to its inherent teaching effectiveness, with respect to both scientific and general education. Further questioning concerns the educational value of the laboratory in relation to its cost in dollars, in student time and in teacher effort. Probably the most significant challenge to traditional laboratory methods has been the use of demonstrations. While these meet the test of cost and provide stimulation and entertainment, they lack the prime essential of having the student DO as well as SEE. Demonstrations therefore provided at best a substitute for laboratory work and have not answered the original problem of making laboratory teaching more effective. We believe that the introduction of semi-micro techniques provides such an answer.

The semi-micro technique utilizes much smaller quantities of reagents than the traditional macro method, the ratio ranging from perhaps one-tenth to one-hundredth. Thus, for example, where a macro procedure might call for 5 ml. of a certain reagent solution the semi-micro procedure might use 0.5 ml. (10 drops) in some variations, down to 1 drop in others. At the risk of oversimplifying the comparison we may consider the 10 drop technique as representing a simple reduction in scale of the macro technique, with the apparatus being similar but smaller. On the other hand, the 1 drop technique uses modified or substantially different apparatus and procedures. In practice the 10 drop technique provides several interesting alternatives, such as the separation of precipitates from supernatant liquors by centrifugation or by filtration, the latter being susceptible to gravity, suction and pressure types.

We have attempted to evaluate the potential contribution of semi-micro techniques to the chemistry laboratory at the secondary school level. In this effort we have had the cooperative assistance of a number of high school teachers. Our study comprised an operational analysis, a compilation of questions raised by the cooperating teachers, an economic analysis and an educational analysis. The first two portions of this study have recently been published elsewhere (*Journal*

¹ This material was taken from a thesis presented in partial fulfillment of the requirements for the degree of Master of Arts in Science Education.

of *Chemical Education*, 26, October, 1949). Our independent economic analysis, based on current prices, substantiated the conclusions of others to the effect that apparatus costs in initially equipping a laboratory are about the same for macro and semi-micro techniques while the latter offer a substantial saving in chemical costs and may be expected to offer a saving in laboratory maintenance. This report is concerned with our educational analysis.

Use of the semi-micro technique, with its smaller quantities of reagents, makes it practical to provide each student (or perhaps each pair of students) with a reagent kit containing the most frequently used materials in 8 ml. or 15 ml. bottles, each equipped with its own dropper cap. These bottles may be conveniently assembled in wood or plastic trays, or in low cardboard boxes. We note that the construction of trays may be a suitable project for manual arts classes. Chemicals used only occasionally may be dispensed in 30 ml. dropper bottles, one set for each five to ten students. Some chemicals are used so rarely that they are conveniently available from perhaps a single set of dropper bottles. Bottles for solids are available in suitable sizes and students can be taught to tap out single crystals. While individual teachers will have divergent opinions as to the distribution of supplies among the three frequencies of bottle use, we propose an initial even distribution. For small classes the second and third groups merge. In such cases our experience indicates that if the most frequently used third of the reagents is provided in individual kits the benefits are significant.

Before considering the detailed educational analysis it may be well to note certain generalized observations to which we shall make frequent reference. The use of small quantities of chemicals saves the student time in procedures which are used often, most obviously filtrations and evaporations. The time saved can be used in a variety of ways subject to the student's and teacher's discretions. The use of small quantities further develops in the student attention to details such as relative quantities of reacting chemicals and trains him in precise observation. The use of individual reagent kits saves the student considerable time otherwise spent in traveling between his bench and the reagent shelf and in standing in line awaiting his turn. We note that the teacher spends a good share of his time policing the line at the macro reagent shelf and in replenishing reagent stocks. This time should be spent in activities of greater educational value.

R. W. Leighton² has presented a comprehensive list of objectives towards which laboratory work should strive. We shall follow this list in detailing our opinions of the merits of semi-micro techniques. While

² R. W. Leighton, *Studies of Laboratory Methods of Teaching*, pp. 14-20. Ann Arbor, Michigan; Edwards Brothers Inc. (1945).

we feel that in no case does the macro approach have any significant advantage over the semi-micro, there are numerous educational factors in which the semi-micro approach is definitely advantageous.

Teaching effectiveness is increased when the semi-micro techniques are used. Probably the most important reason is that the teacher has more time to teach, less time being spent in routine operation of the laboratory and in efforts generally related to discipline. The students spend a higher proportion of the time at their individual stations, making it convenient for the teacher to consult each student about his individual difficulties. This leads inevitably to the teacher's consideration of each student's individuality, his interests and preferences, and gives the teacher better opportunity for assessing each student's capabilities. Such an opportunity is particularly welcome to a teacher who is interested in counseling and enjoys helping the student plan his career. Obviously the teacher is in a better position informally to suggest additional experimental work of special interest to the particular student. To mention just one specific example, some students are interested in dewaxing pine needles with various solvents before treating them with chlorine water.

Substantially all the criteria which Leighton lists as related to personality traits are better met by the semi-micro techniques. These techniques lead to individual work on the part of each student and hence develop self reliance through the repeated exercise of personal judgment. The ease of conducting an experimental detail permits development of initiative and originality. It is important to note that hazards are materially lessened by the minuteness of the quantities involved in semi-micro procedures with the result that originality may be permitted at an early stage in chemical experience. Specifically we note that students become accustomed to adding a single drop and observing results before proceeding further whereas such care is a rarity under the macro approach. Development of these traits leads to ability in making decisions based upon a better understanding of the detailed problem confronting the student.

Under the same general classification of personal traits we also list personal neatness in the laboratory. This important consideration is well developed by semi-micro techniques since the use of individual reagent kits fixes responsibility for contamination, waste and spillage. The student knows that he alone will suffer the consequences of his sloppy handling of reagents and that his own faults will not be hidden as a class error. We note also that the spillage and breakage more or less unavoidable during first experiences in the laboratory can be much less hazardous to the student's person and clothing as well as to the laboratory equipment.

The semi-micro technique is advantageous from the viewpoint of

enhancing the student's acquisition of skills. It not only provides more manipulative approaches in certain situations such as filtration but also saves the time needed to permit this increased breadth of experience. We feel that semi-micro manipulations are rather immediately transferable to the status of avocation as they can be better handled in a home laboratory than traditional macro manipulations, again with less hazard to the operator, his family and the dwelling. We note, however, one hazardous temptation, that of improvising a centrifuge.

Many of the previously noted benefits of the semi-micro approach are also pertinent to the development of proper scientific attitudes. For example, the ease of producing large variations in the relative quantities of the reagents leads the student to an awareness of stoichiometric equivalents. Thus amphoteric behavior is noted more readily at the semi-micro scale. As another example we note that the student's use of drop quantities leads him to an appreciation of the factors affecting the size of a drop. The general tendency then is towards the development of more accurate thinking along with more accurate measurement (balances must be used more carefully), and the development of keener power of observation. The time-saving feature permits more verification of results and wider acquaintance with chemical phenomena. The minimization of hazards also permits the use of chemicals which are sometimes avoided for this reason alone. For example, hydrogen sulfide may be used in semi-micro procedures without the use of any special hoods.

It seems to us that the advantages of the semi-micro approach to a first chemistry laboratory, both from the viewpoint of the student and that of the teacher, lead to an increased spirit of investigation in the laboratory. That is important, not so much as a matter of producing research scientists as typifying and continuing the restlessness of the American spirit with its continued search for better methods and improved results.

We wish to acknowledge gratefully the cooperative assistance of the following science teachers: Dr. Dresser, Proctor High School, Utica, New York; Mr. Dudleston, Utica Free Academy, Utica, New York; Mr. Fillips, Whitesboro Central School, Whitesboro, New York; Mr. Giltner, Norwich High School, Norwich, New York; Mr. Hewitt, Madison Central School, Madison, New York; Mr. Knutty, and Mr. McCabe, Whitesboro Central School, Whitesboro, New York; Mrs. Smith, Hamilton Central School, Hamilton, New York; Dr. Webb, Supervisor of Science, Syracuse, New York; Mr. Whitmore, Rome Free Academy, Rome, New York.

THE ADOLESCENT AND ARITHMETIC*

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The problem of the adolescent and arithmetic is a special case of the problem of the child and organized subject matter. We teachers must know the kind of behavior to be expected from our age groups and some of the most important forces that bring about or influence this behavior. We must have a competent command of our subject matter field and be aware of ways that it mingles with other subject matters and permeates significant life problems outside of the classroom. Our most severe challenge is to provide, in collaboration with the children, those experiences which lead to the growth of those understandings, abilities, appreciations and attitudes most valuable for the individual, and the kind of society whose improvement is the aim of the group that sponsors the school.

At the 7th and 8th grade levels we would probably be very happy to have a general, approximate formula for teaching success in which we could substitute for two of the many variables the values, "adolescent" and "arithmetic." Such, however, is not to be the case. Not only would such a formula be extremely approximate but we would have only partial control over the limited number of independent variables that we felt were operating.

Despite this lack of an easy solution we can list those characteristics that seem distinctive for the adolescent age group. There are dangers in this practice, however. First, we thereby ignore those characteristics that are common to all learners, irrespective of their ages. Second, any age group contains within itself not a homogeneous membership but individuals who differ from each other in a variety of ways. With these perils in mind let us attempt to spot the dominant traits of adolescents and take into account, at the same time, some of the deeper reasons for these traits.

A description of these has been given in various places, especially in works on adolescent psychology. One writer observes: "At about the age of nine or ten most children seem to be exceptionally well-adjusted, happy, compliant, reasonably responsible, obedient, and through with most of the unpleasant habits and problems of early childhood. And then, quite unexpectedly, at eleven or twelve this beautiful adjustment breaks down. The child becomes more restless and unstable, less responsible, less obedient, often openly hostile to

* Read before the Junior High School Group of the Central Association of Science and Mathematics Teachers, Chicago, Nov. 26, 1949.

the adults he loves best. His carefully trained habits of order and cleanliness are lost. He is careless in his personal appearance, his language, his work Adult standards and appeals seem to have little claim for the pre-adolescent, but he is almost slavish in his dependence on the approval of the gang At the same time he becomes increasingly difficult to teach by the traditional methods. His attention is fluctuating and hard to enlist. His creative powers seem to wane. Much of his energy goes into day-dreaming, and anything serves to distract him. His interest in abstractions is at a low ebb although he enjoys a concrete type of manipulation and is intrigued by mechanical gadgets of all sorts. He is at war with time, never beginning anything soon enough"¹ Another study made of the development of children by a faculty over a period of years contains statements like the following: "Status with peers is usually far more important than adult approval at this time. Desire for group approval increases the amount of participation in clubs and groups."² "Children of these ages are best able to solve problems involving concrete situations within their own experience." "The attention span of children of these ages is short in group discussion; it is still difficult for them to concentrate for a long period of time. Girls tend to have a greater capacity for concentration and a longer span of interest than boys." "Children of this level enjoy concrete manipulations of things. Their understanding of abstract concepts continues to grow but is still very weak." "These children still tend to draw conclusions from scanty and improperly observed data."³

The kind of behavior just described has been considered to be due to the adolescent's urge, more or less conscious, to free himself, to some extent at least, from adult control while retaining the privilege of returning to the parental knee occasionally when problems become too severe. The adolescent is neither child nor man. In this in-between status his behavior varies as he takes on first one of his roles and then the other. He hardly knows himself. He is trying to make a very difficult adjustment. He is insecure and uncertain. He is the victim of developmental forces that frequently make his meanderings resemble those of a cork on a wave. It is no wonder that Dr. Blos observes that he is very difficult to teach.⁴ His interest in being one of the gang does not make his guidance any simpler. It is not surprising that his attention fluctuates and that he is easily distracted. How can he take any interest in abstractions when he cannot study relationships long enough to educe a relationship? That he enjoys a

¹ Progressive Education Association. *Mathematics in General Education*. Chapter 12, "Understanding the Student," pp. 273-274, Appleton, 1940.

² University School, Ohio State University. *How Children Develop*, pp. 42-43. Columbus, Ohio, 1946.

³ *Ibid.*, pp. 46-47.

⁴ See (1) above.

concrete type of manipulation does not seem strange, either. Certainly this kind of activity correlates better with his driving restlessness than attention to abstractions and generalizations.

In summary, then, we find these to be the outstanding marks of the adolescent: lack of security, resistance to authority, loyalty to peer groups, restlessness, instability, lack of a sense of responsibility, short attention span, a liking for manipulation of concrete objects and a tendency to draw conclusions from scanty and improperly observed data. We must reiterate, however, that these characteristics are not isolated but related.

Next, let us look at the characteristics of arithmetic and correlative objectives for teaching the subject. First, arithmetic is identified by many children as an operational activity, in which certain actions are performed on two or more numbers to get specific answers. Second, arithmetic is considered by many qualified adults to be a system of ideas. The Greeks distinguished these two kinds of arithmetic by naming the first *logistica*, or the art of computation, and by christening the second *arithmetica*, or the theory of numbers. These ancient philosophers exhibited their scorn for *logistica* by turning over calculations to their slaves; however, they considered the theory of numbers as worthy of study to the extent, in the case of the Pythagoreans, of making their religion and philosophy subservient to the properties of certain classes of whole numbers. Third, arithmetic is a socially desirable possession, used by individuals in applying skills and understandings in a utilitarian or interpretive way. It is the arithmetic used by the child, consumer, home-maker and citizen in their daily activities, usually outside of the arithmetic classroom.

However, these three kinds of arithmetic are not independent. Performing the skills of arithmetic is usually accompanied by some understanding, although it may be of a low degree. When taught with adequate understanding skills seem to become more permanent and susceptible to wider use. On the other hand, exclusive attention to meanings and relationships to the neglect of certain skills can lead to considerable frustration in applying arithmetic to social situations. Here again, however, the possession of understanding is usually associated with some skill. The relationships of the three kinds of arithmetic is analogous to that of skills, theory of plays and adaptability to varying game conditions in the great American sport of football. Deficiency in any of these three is almost a sure way to prevent consistent winning.

Similarly, in the case of arithmetic we aim to so teach arithmetic that the adolescent acquires some skill, based on a foundation of meaning and understanding, and achieves some ability to apply his arithmetic to socially significant problems.

We must also recognize one additional factor in arithmetical education. That factor, analogous to "spirit" in a football game, is the attitude toward arithmetic and its use. We must so teach that the adolescent has a favorable reaction to arithmetic and an alert anticipation that he will use his command of arithmetic in social situations. If the teaching and learning of arithmetic leave the child with the nausea of dislike he will push the dish aside as soon as he leaves the table. Arithmetic in the future will be part of his diet only if starvation threatens. It will rapidly cease to be a nourishing element on his educational menu. If the student faces situations having quantitative elements with no or very little expectancy of using arithmetic, his mathematical learning is like a useless appendage in life situations.

Let us next look back at the characteristics of adolescence to see what implications there are in these for the method and content of arithmetic.

The need for security can be partially met by the attitude of the teacher toward the student. Patience and encouragement seem to be necessary ingredients in this attitude. Another way to increase security is to make sure that the adolescent really understands what he is doing when he uses arithmetic. A third way is to teach methods of checking that will place a student "on his own." The sureness of arithmetic results is needed to balance somewhat the numerous uncertainties in the adolescent's life.

Resistance to authority can be reduced somewhat by emphasis on the same self-checking procedures and by using occasions to give the student choices when this is possible.

Loyalty to peer groups can be used in both a competitive and a co-operative way. Teams can compete in kinds of achievement for which groups can be evenly matched. Then, in problems requiring the collection of data each of the sub-groups can contribute its share to the common pool.

Restlessness, instability and their resultant, *short attention span*, suggest that the teacher should reduce the time devoted to oral explanation. They also imply that classroom activities should be characterized by variety instead of long periods of the same activity.

Some of these activities are suggested by the adolescent's *liking for manipulation of concrete objects* and his *tendency to draw conclusions from scanty and improperly observed data*. These traits suggest that there should be occasional laboratory periods in which measurements are made, say of the circumference and diameter of round objects, in which the data are studied for the approximate relationship and, finally, the accepted relationship expressed in sentence or formula form. This is a good way to make the student conscious of the dangers of the inductive method of drawing conclusions. Areas, volumes,

graphic data, scale drawing and map reading contain opportunities for these laboratory procedures.

Finally, the difficulties of teaching adolescents may be reduced by using problems and activities of potentially high interest value. The teacher's art lies in starting with the adolescent's preference for immediate values and leading him on to concerns whose pursuit will be of value in both his present and future living. The content of the usual junior high school mathematics curriculum does not always contribute to this end. Even authors of textbooks are conscious of that.

In more than one text the review of the skill operations in arithmetic dominates the first chapter. No one doubts that the skills need improvement. However, interest is considered a necessary condition for efficient drill. First chapters on computation for the adolescent are hardly charged with motivation since he has faced the same type of calculation for the past several years. Why not start with a unit on measurement or, if computation must be treated at this point, why not show new methods of checking or deal with other number systems besides those which have ten for a base? Interest can be improved by giving a new treatment to old material or by giving an old treatment to new material.

The Commission on Post War Plans of the National Council of Teachers of Mathematics has criticized the use of certain socialized arithmetic at the junior high school level. "Generally speaking, the study of investments, taxation, insurance, and the like, is hard to motivate for immature pupils However, thirteen- and fourteen-year-old boys and girls do not have the mathematical maturity to enable the typical teacher to do a respectable job, to say nothing of making the problem challenging. Unfortunately, some curriculum specialists (including enthusiasts for consumer education) do not know that arithmetic problems may be practical and very interesting to adults and yet be deadly boring to youngsters in the seventh and eighth grades, and remote from their interests and needs."⁵ In the light of our knowledge of the interests of these students, such topics as athletics, ways of earning money, savings accounts, ways of spending money, problems about foods and diets, problems about school and class budgets, Boy and Girl Scout activities, problems about growth in height and weight, and measurements of distances, speeds, areas and volumes connected with trips, home and shop activities of a construction nature are much more likely to contain the germs of interest. If some of these lead to investigations of profits, dividends and taxes, the amount of motivation should be greater than if these matters of adult concern were introduced "out of the blue" for child

⁵ National Council of Teachers of Mathematics, The Commission on Post War Plans, *The Role of Mathematics in Consumer Education*. P. 4. Washington, D. C. 1945.

consumption. Perhaps the greatest and richest source of good problem situations is in the activities of students in the particular neighborhood and community in which they reside. These will vary from farm community to industrial community to suburban community. They will also vary with the economic level of the major portion of the school's population.

In conclusion, the improved teaching of junior high school arithmetic is a function of the child, the nature of arithmetic and the nature of the societal life that is to be bettered through the medium of the school.

PRESSURE EXPERIMENTS

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I. PRESSURE IN A SOAP BUBBLE

Provide a glass T-tube with a well-greased stop-cock on the third arm. On this arm attach a length of rubber tubing, the open end of which is to be held in the mouth. Now dip each of the T arms into a soap solution and carefully blow bubbles on both ends. It is unlikely that these two bubbles will be *exactly* the same size. For our purposes see to it that one bubble is *much larger* than the other.

Now ask the class what will happen when the stop-cock is closed and each bubble is connected with the other but not with the air outside. The answer invariably is that both bubbles will come to the same size, that is, *that the big one will blow the little one up*. Do you know what will happen?

II. OSMOSIS; OSMOTIC PRESSURE

It is not commonly known that cellophane behaves as a semipermeable membrane. Across the mouth of a thistle tube stretch a sheet of cellophane paper. A large enough sheet may be gotten from a package of cigarettes, if opened carefully. Seal it tightly around the neck of the tube with sealing wax. Now fill the tube to some arbitrary level with a colored solution of sugar or salt and immerse the mouth end in a beaker of distilled water. Support the tube vertically by a standard and clamp. A rise of the column is shortly observed due to the migration of molecules in the direction of the greater concentration. Overnight a substantial column can be obtained.

Prepublication orders for *A Half Century of Teaching Science and Mathematics* are being accepted now by Ray C. Soliday, Box 408, Oak Park, Illinois. The price on these orders is \$2.50. After September 1, 1950, the price will be \$3.00.

HYBRIDS

AARON GOFF

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When a tiger mates with a lion and produces young known as tigrlons, it is news. Very properly, people are a little amazed that such a cross should produce offspring. The very act of mating is the result of several years of acclimatization which the two parents must undergo before the reproductive urges become great enough to accomplish the act. Such hybrids have been produced on occasion since 1927 when the first successful mating in modern times, of an African lion and a Siberian tigress took place in a Munich zoo. In 1936, one of the tigrlons was purchased by the Central Park Zoo and has since been an important attraction in that collection of animals. Recently, reverse crosses of lionesses and tigers have produced ligers.

The whole question of crosses between apparently unrelated species of animals or plants is still confused. Even the criterion of resemblance cannot be used to predict successful fruition. Several species of *Drosophila* (the famous experimental insect in genetics), have been found to be incompatible to the extent that fertilization results in no complete development of eggs into larvae. Similar results have been observed with species of moths which appear to be closely related. Even the biologists who use the cross as the test of classification are hard put to explain why insects which differ in a few superficial characteristics, so that one is called *Drosophila obscura*, will not produce offspring when mated with *Drosophila melanogaster*. Where mating is actually accomplished, the explanation of infertility revolves around chromosome matching and defects. However, when widely separated animals such as sea urchins and mollusks belonging to different phyla, are crossed with human and chemical help, the sea urchin egg seems to develop without the aid of the male sperm chromosomes. In this case we really have another example of the work done by Jacques Loeb early in the 20th century, in which sea urchin eggs were stimulated to produce larvae by pin pricks and chemical action. On the other hand, Stockard found two varieties of dog, the St. Bernard and the Great Dane, were incapable of producing viable young, all hybrids succumbing by the age of three months to some form of paralysis.

Even when the American bison, *Bison Americanus*, is mated with the common cow, *Bos taurus*, there is difficulty on the part of the cow in carrying through to birth. Few males are born, and these are extremely large. Many of the cows die in giving birth to such male hybrids, mainly because of the size, and certain deficiencies of the amniotic fluid. Females are quite easily carried and in turn, can be

fertilized by the bison to produce a vigorous, hardy and large type known as the cattalo. The Canadian government, as well as many American breeders are exploring the possibilities of this hybrid since it is resistant to many of the ordinary cattle diseases, it can forage better for itself, does not drift before the wind and snow, and is a better meat producer than the ordinary Aberdeen Angus, Hereford or Shorthorn which serve as mothers in the cross.

In Brazil the hybrid offspring of the zebu (*Bos indicus*) the typical humped species of India, and the domestic cow have proved to be very popular because of their ability to fight off disease and to resist the hot climate. Many crosses have been made between the *Bos taurus* and the cattle of Asia and Africa. With yaks, gaurs, gayals and Brahmins, only the female offspring seem to have the power of reproducing. The zebu-cow cross however, produces fertile males and females, another reason that they have found favor in Brazil despite their tendency to be wild and difficult to handle.

In this country, especially in the south, the hybrid characteristics of the mule have made it a standard farm animal. Like the cattalo, it is stronger, more disease resistant, and more independent for food than its parents. In the breeding of mules, jackasses (*Equus asinus*), which have been domesticated at least as long as horses, are carefully selected for mating with mares (*Equus caballus*). The reputation of the mule really belongs to its father, commonly known as a donkey. Stubbornness is passed on only in part to the mules, which, when properly handled, are capable of doing a tremendous amount of work on a farm. The hinny, produced by the reverse cross of stallion on female ass or jennet, has not proved as desirable since she lacks strength, and because jennets are kept busy producing more asses. It is interesting to note that George Washington, in 1785, imported Spanish and Maltese asses for mule breeding purposes. He extolled the virtues of mules, their size, tractability, surefootedness, durability and foraging tendencies. Like all observant men, he noted too, the sterility of mules which had become traditional since Herodotus and Aristotle mentioned it in their writings. In more recent times, however, authoritative reports of fertile females have been accepted by geneticists. Males, while they seem to have unusual sexual urges, are lacking in fundamental testicular tissue, so that whatever sperm cells are formed are defective. Female mules, on the other hand, have been known to secrete milk without pregnancy, and have born young which resemble either mules or horses. It is believed that the female mule occasionally produces a fertile horse-type egg, which, if fertilized by a horse sperm results in a colt, or if fertilized by an ass sperm develops into a mule.

The hybrid zebroid, produced from a horse-zebra cross is commonly used in circuses because of its attractive chocolate brown stripes and extreme docility. The zebroid is one of the few domesticated animals capable of resisting the dreaded tsetse fly. The Russians of the southern Ukraine have found the mishort, a similar cross of wild horse with female zebra, to be a strong and tractable farm animal. On occasion, even jackass-zebra offspring have been successfully produced but have no general use. These are known as zebrules.

Several times since 1808 when Cuvier first reported it, the swan-goose cross has been successfully consummated. This bird has been named the swoose by Drs. Knox and Quinn of the United States Department of Agriculture. It has a long neck, but in other respects is the average of its parents. While common hens have been crossed with peacocks and turkeys, the mongrel offspring are of no commercial interest at the present time. Dog-wolf, skunk-ferret and goat-ibex crosses have also been successfully accomplished, but involve so many difficulties that there are no indications of commercial exploitation. Tropical fish fanciers have reported many successful hybrids.

On the island of Sardinia, it is common practice to raise hybrid goat-sheep offspring which are exceptionally fine milk producers. Although the female hybrids seldom carry through a pregnancy it is common practice to raise mixed goat and sheep herds which frequently produce hybrids which are valued for their milk. In such cases where unlike animals are crossed, it has been found necessary to permit the dissimilar animals to become accustomed to each other, the ideal method being to raise them together as soon as they are weaned.

In many types of plant and animal breeding it is customary to "hybridize" by crossing different families within the same species. There is a vigor or heterosis apparent in the first generation which has made this practice standard among farmers for corn, tobacco, peas and tomatoes. In improving stock, the selection method is used in which a particular trait, such as size, or resistance to disease is the goal. In each generation those plants or animals are selected for breeding which demonstrate the desired characteristics to the highest degree. In this way cattle have been improved, so that the modern cow raised for meat is twice the size of those bred on farms in the Middle Ages. Butter content has increased from a record 567 pounds in 1904 to over 1,000 pounds in the 1940's. In many cases selection has resulted in the formation of pure lines which continue to be superior. Often, however, only the first generation shows the vigor which Mendel noted in his peas. There seems to be an additive effect

when dissimilar genes are present in the same organism for the first time, which disappears through segregation and perhaps cooperative functioning.

Among plants the most remarkable cross of all is that which has been reported several times since 1826, and which was the subject of intensive work by Russian geneticists. It involves the cabbage (*Brassica*) and the radish (*Raphanus sativa*) which produced a new plant which has been given a separate genus name, *Raphanobrassica*. The latter is a vine producing plant which resembles its parents in no outward aspect. It is not self-fertile, but some seeds have been produced by crossing it back with the cabbage. At present there is no significant root or fruit which appears to be of economic importance reported from this remarkable plant.

Although most attempted crosses between plants or trees, by cross pollination, have been ineffective, several are known which are noteworthy. The James River walnut, one of America's largest and most remarkable hardwood trees is a cross of the Persian walnut and the common butternut. It is 166 feet high, spreads 134 ft. and has a circumference of 31 ft. The plumcot, resulting from an apricot-plum cross and the limquat, from a lime and kumquat, are hybrids which may become of commercial importance as they are grown in larger numbers. Contrary to popular opinion, the grapefruit and the nectarine are not hybrids in the sense of being the result of crossing lemons and oranges or peaches and plums respectively. Both were known to the ancients as fairly well established kinds of fruit. It has been found impossible to date to effect successful fertilization of pear ovules with apple pollen or vice versa. Negative results have been similarly obtained with wheat and oats, oats and barley, wheat and barley, although partially fertile hybrids have been produced from rye and wheat, and pumpkin and squash.

The question of human-animal hybrids brings to mind the statement of Pliny who wrote in the first century A.D. that the "Ourang Outang was reportedly the man of the woods, born from lust of Indian women who mix with apes and monkeys with detestable sensuality." He expressed a thought which seems to be universal in the mind of men. Is such a cross possible? At the present time, according to anthropologists, there is no authoritative record of any hybrid produced by the mating of a *homo sapiens*, including every race of man, with any other species or genus. We must conclude in the absence of any further reports, that the attempts of the Russians a number of years ago to effect a cross between ape and man, must have been sterile of offspring. Of course, we do know that gorillas are sexually attracted to men, some of their flirtations having taken on the aspects of invitations to contact. Among the apes there is more than a suspicion that chimp-gorilla hybrids have been produced,

several mongrel appearing apes having been captured. One "Mafuca" was received at the Dresden Zoo from Loango, Africa in 1874 and attracted a great deal of attention from the public as well as professional taxonomists.

However, we have no conclusive answer to the question, and experiments with artificial insemination may at some future date prove conclusively whether or not human sperm can successfully fertilize anthropoid ova. All physiological and anatomical comparisons, of course, point to close kinship between all members of the primate order.

PACIFIC COAST WAS BALMY 50 MILLION YEARS AGO

Modern man, if he were transported back through geological time about 50 million years, would find a strange climatic situation in the Pacific area.

As far north as Puget Sound he would be in the tropics. He could sit under a palm tree, and watch the surf pound against coral reefs.

He could bathe in warm waters, and catch tropical fish. He would have to keep on the alert, however, for crocodiles.

This is a partial picture of a section of the ancient world being pieced together by Dr. J. Wyatt Durham, associate professor of paleontology at the University of California. It is based upon Dr. Durham's studies of fossil specimens of marine animals in the Pacific Coastal region during the Eocene epoch, and upon research by others in allied fields.

The scientist said that since the Eocene epoch there has been a gradual shift of the tropical climate southward. This gradual shift was interrupted by rapid fluctuations both north and south during the Ice Age.

Dr. Durham has also refuted the widely held theory that the poles and continents shifted around during this past age. He points out that the evidence indicates no major shifts of either the poles or continents in the past 50 million years.

For example, advocates of the theory of shifting poles would place the Kamchatka peninsula within 15 degrees of the North Pole at one time in this past age. However, the fossils of marine life of Kamchatka for that period are representative of a warm water environment. These animals could not have existed within 15 degrees of the North Pole, therefore the pole must have been in approximately its present position.

X-RAY TREATMENT FOR TWICE AS MANY PATIENTS WITH NEW MACHINE

Twice as many cancer, leukemia and other patients per day can be given X-ray treatments as formerly was possible with a new machine announced by the General Electric X-Ray Corporation at the meeting of the Radiological Society of North America.

The machine can deliver X-rays at voltages from 100,000 to 250,000, said to be the widest range of radiation ever produced by a single treatment unit. This wide range and the machine's "phenomenal intensity" are due to use of a beryllium "window" in the tube. Because beryllium is more transparent than glass to the passage of X-rays, the new machine can, if desired, be made to deliver nearly twice the number of roentgens per minute that are produced by earlier tubes in its class. (A roentgen is the unit of measure of radiation.)

The new machine, called the Maxitron 250, also has a new style tube which makes it easier to use in giving X-ray treatments to such parts of the body as the armpits and neck which are difficult to get at with other types of machines.

ATOMIC ENERGY IN AMERICAN LIFE AND EDUCATION*

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Atomic energy already has had greater impact than most of us realize on our lives, our nation and the world. Further, it is here to be reckoned with for the rest of human existence.

The way we handle this tremendous force—a force for vast destruction or for rich benefits—will profoundly change our future way of life and, indeed, the whole course of history.

That this is so need hardly be told this audience. With your keen interest in science I know you are already aware of the most important facts and issues involved. Also, I am sure that as educators you recognize the educational challenge of atomic energy—the enormous task of trying to bring about understanding of the major facts and implications of atomic energy by our people and by peoples everywhere.

In the more than four years since Hiroshima and Nagasaki, I am certain you have done a great deal of reading and thinking about atomic energy. You all have surely explored and accumulated many ideas on what to do about atomic energy. You have no doubt also actively engaged in atomic energy education both in the classroom and in adult groups in your communities.

Assuming this to be the case I have little that is new to offer you. It would be more profitable for us to share our ideas in a round-table discussion. But, since this is not feasible here, I shall talk about certain points which I feel to be important and trust that this will re-emphasize, restimulate or challenge your thinking on this all important subject.

First, let me state that in the broader sense my subject actually is "Science in American Life and Education." This is true because atomic energy is in reality part of the very broad field of atomic science. And, since atoms make up our whole material universe from microbes to man to nebulae and atoms enter into all material processes, atomic science is fundamental to all science. The paths and bypaths of all fields of science are becoming increasingly and inextricably interwoven. This needs continually be to emphasized.

Furthermore, we must recognize that atomic energy is only one case, even though it is a spectacular one, of the many developments arising from science which influence our American life.

* Address before the Central Association of Science and Mathematics Teachers Friday, November 25, 1949, Chicago, Illinois.

To tackle this broader subject I have attempted to divide my remarks into the relationship of atomic energy and science with each of the following major factors in our American life: our national security, our material welfare, our democracy, our religion and our education. The order of discussion is not intended to indicate relative importance. These factors are all vitally interdependent and remarks about one actually involve all the others.

NATIONAL SECURITY

World Wars I and II demonstrated emphatically and spectacularly that success in war depends on preeminence in science and the applications of science. Scientists and applied scientists, or engineers, led the way in improving our capacity to wage war—to wage it in all its total aspects from our home-front productivity to our war-front effectiveness. Our scientists became in quite a real sense our top “warriors.”

Increasing realization of the vital role of science and scientists in our national security has changed to a marked extent the relation of science and government. Whereas before World War I science in the United States was supported mainly by educational institutions and private philanthropic organizations, it is now supported mainly by government. Furthermore, the largest proportion of government funds for research and development comes from the Armed Services or other agencies concerned with weapons of war.

I do not point to this as being all evil. It has good points as well as bad. Science needs and justifies large scale public support, and the results of most government supported research and development have as great or greater application for peacetime benefits as for military purposes.

Even if support of science for military preparedness appears to be an evil it is now a necessary evil. Scientists recognize that the present world situation calls for the fullest pursuit and development of science in the interest of defending the freedoms and purposes of our way of life. Scientists are realists as well as idealists.

Yet, the scientist cannot help but be wary. He cannot forget his ideals. He must reflect seriously not only upon defending but on preserving our freedoms and way of life. He must keep in mind the broad relationships between science and the basic principles of our way of life—between science and all the factors that enter into national security.

First, scientists must be leaders and not followers in research and development. To lead they must have a large measure of scientific freedom—of undirected, imaginative exploration—of “pure” re-

search. The effort spent on applying science to specific ends must not overbalance the effort on bringing forward the new fundamental knowledge that must precede new applications.

We must be aware of the danger that we might spend too much effort on developments that appear to be of immediate military importance and neglect the acquisition of new fundamental knowledge. In a number of years we might thereby find our developments surpassed and outmoded as a result of new scientific discoveries. In each war military men and engineers have depended on the science accumulated during peacetime to develop new applications for war. A primary requisite of national security therefore is to provide adequate support for unfettered fundamental scientific research.

Secondly, the problem of secrecy in science and its relation to national security must be thoroughly analyzed and continually kept under scrutiny. Secrecy in science could "kill the goose that lays the golden eggs." Unnecessary exercise of secrecy in science would hamper the exchange of information—the freedom and morale of workers—which has been responsible for the great flourishing of science and technology in this country.

Too much secrecy could also make us as ridiculous as the fable of the ostrich with its head in the sand! It might lull us into believing that because we are keeping so much information secret we know more and have accomplished more than scientists anywhere else.

By this I don't mean that we should release information which would be of particular military value to potential enemies. Certainly in some respects we can keep ahead of others by concealing information that we are fairly sure we alone know. For example, much information on the development of atomic energy for industrial power may need to be concealed because of the almost inextricable relationship between the military and civilian aspects of this development. Atomic power units and atomic reactors have the dual feature not only of using fissionable material but of producing fissionable material—material which upon purification could be used for weapons.

But secrecy or "security by concealment" is a complex thing and has limitations. It has inherent in it a great deal of the "Maginot Line" or static defense philosophy. Since it is so restrictive by nature and contrary to the way in which we have made most progress in the past, it cannot help but retard our speed of accomplishment. We make this sacrifice in the hope that our potential enemies are not as smart and industrious as we are and that it will take them much longer than us to make the same accomplishments. There is of course some value in this but the recent disclosure of unexpected progress in making atomic explosives by Russia indicates that our margin of lead is not

as great as we might have hoped. We must reexamine our policies of concealment in the light of fact rather than hope.

Security by concealment is also the type of security which if over-emphasized and misguided by inadequate or power-seeking leadership can lead to the incipience of a police state.

To make security by concealment effective in atomic energy developments it has been necessary to make FBI loyalty investigations of people engaged in even minor phases of these activities.

As the report recently released by the Joint Congressional Committee on Atomic Energy following their investigation of the AEC states: "Denying information to the potential enemy involves a probe into the minds and hearts of the human beings who work on our atomic energy project. If their character, associations, and loyalty fail to meet certain standards, they are refused access to restricted data as defined in the McMahon Act. Since direct contact with the complete inner workings of a man's brain cannot be established by any means, even through hypnosis or the use of drugs, reliance is placed upon his spoken utterances, the company he keeps, the organizations he joins, the reputation he enjoys, and similar matters—as developed through an FBI investigation."

Such personnel security investigations must of course be subjective to a considerable extent but the clearance system should aim to be as completely objective as possible. Every effort should be made to make the system afford as far as possible the moral and legal protections guaranteed citizens under our democratic form of government.

Furthermore, emphasis on security by secrecy can and does become a creeping, an unobtrusively expanding thing. As it grows, suspicion is cast on more and more persons and more and more people must be investigated. Many of the scientists working in universities or research institutions on non-secret or unclassified work supported by the Atomic Energy Commission must now undergo FBI investigation. More recently it has become necessary even for students who wish to study non-secret and freely taught subjects under fellowships financed by the Atomic Energy Commission to obtain FBI loyalty clearances.

More than any other group in our society, our scientists—including many who do not have access to secret matters—already have had their private affairs, habits, associations, minds and hearts probed into and the details recorded in extensive files. Millions of government workers and many others who obtain federal funds are investigated to some degree or other. It is conceivable that such investigations might be extended to everyone who obtained federal funds from any source and finally to everyone in our country. The expense to

the nation would of course be tremendous. But more important it would be the basis for a possible police state.

Although certain checks on loyalty have merit and in highly secret work are essential, they raise problems fundamental to our concepts of basic rights, liberties and the integrity of the individual. We should examine closely the extent to which personnel security investigations are expanded—not only from the standpoint of the very great expense involved but from the standpoint of being anti-American or contrary to many of our basic concepts of government.

Let us consider the case of a person already working on the atomic energy project. If the investigation discloses that he may be a "poor security risk" or is of questionable loyalty, the person is given the opportunity of a hearing. The difficulty is that because secret information is involved, the hearing must be "closed," i.e., it must be conducted only before a selected group of persons who have already received FBI loyalty clearances. The person thus cannot have an open trial in the customary democratic manner. The Atomic Energy Commission is to be commended however for endeavoring to make such hearings as fair as possible even though closed. The persons who conduct the hearings are chosen for recognized ability to be impartial. They realize the difficulties inherent in a closed hearing, and try to be as fair as possible to the person under question. The system has worked quite well only because all the persons involved realize the difficulties and the inherent dangers. It is easily seen however that such a system could be susceptible to errors, to injustice and even to abuse.

In the case of a person who is not already working on the atomic energy project and who does not obtain an FBI loyalty clearance to become employed, the situation is much less fair. In general he is not able to obtain a hearing to determine whether he is being unjustly kept from working on the atomic energy project. In short, persons already working on the project may obtain a closed hearing, but those not on the project may be denied the opportunity to work on the project without being given a hearing of any sort. There are of course good reasons for this situation, but we must not close our eyes to the fact that such a situation exists.

Only part of the answer lies in giving uncleared or questioned persons an opportunity for hearings or trials which are conducted more in the customary democratic way. The eventual answer lies in removing more and more areas of work from the necessity of requiring a full loyalty investigation.

But there is another side to security—this is "security by achievement." Security by achievement recognizes that all our science and

technology is closely interrelated and that our over-all national security is dependent on the sum total of our advance in all fields of endeavor. In many phases of atomic energy development, for example, such as fundamental research in the physical sciences, medicine and biology, in the applications of isotopes, and in many other activities not directly related to weapons production, our national strength will certainly be increased by a dynamic security, that is by reducing restrictions on exchange of information and by making conditions suitable for maximum speed of achievement. In the more highly classified or secret phases one has the difficult task of balancing the gain in our own speed of achievement against the possible assistance we might give to furthering the achievement of a potential enemy.

This calls for a critical and careful analysis of what our over-all national security actually depends on. Certainly our security depends on the strength of our armed forces and our military weapons. It has become increasingly apparent, however, that our military strength is also greatly dependent on the total scientific, technological and industrial manpower of the nation, on the total material resources, on the over-all physical and mental health of the population—in other words, on the entire state of the national welfare—on the total national strength.

Hence, in the problem of security with respect to atomic energy, there is much more involved than stocking atomic weapons or maintaining secrecy over certain amounts of scientific and technical information. We must examine the activity and even lack of activity on each matter with regard to the effect on the over-all state of our national welfare and national strength. This means that in releasing certain information and materials, in relaxing certain government controls, a balance must be achieved between a possible weakening of our immediate military advantage, and the strengthening of our over-all national vigor.

Further we must constantly be aware that our national security is dependent on much more than our immediate military preparedness, no matter how essential this may be. War is now waged not only by armies and by physical destruction, but by economic measures, fifth columns, propaganda and by ideology. We must therefore be strong not only in military personnel and weapons, but in our economy, our national health, our material welfare, our ability to reason through propaganda, and our faith in the basic principles we cherish.

We now come to consider in detail the relation of atomic energy and science to some of these other factors involved in our over-all national strength.

MATERIAL WELFARE

It has long been recognized that advances in science lead eventually to advances in the applications of science—to greater relief from want and sickness—to better standards of living and health—that is, to better over-all material welfare.

This country has always had good scientists and a fairly high level of scientific undertaking, but it is generally recognized that until the last few decades Europe has led us in pure scientific research. The level of our science has continually been improving and expanding and now we may justly claim world leadership in science. Yet it is not for its scientific achievements that the United States is outstanding.

We are much more noted for our vigorous ability to apply science to useful ends. It has been our ingenuity for applying science and our technical skill that has expanded our frontiers, built our great industries and increased our standard of living to higher and higher levels. In recent decades with our increasing material welfare we have been wisely reinvesting more and more dividends into the pursuit of science, that is, into the acquisition of new fundamental knowledge. This in turn has increased our technology and our material welfare. Students of this mutual relationship between science and our expanding economy feel that we have not yet reached the level of support for science which would be optimum for our future welfare.

It has been evident that the urgencies of war produce a great impetus for making applications of science, and that many of these applications have great peacetime as well as military usefulness. For example, such developments as penicillin, antibiotics in general, radar, synthetic rubber, turbo-jet engines, high altitude planes, etc., which came of age in World War II, are now being put to many good uses. It is also to be expected that the outstanding technical achievements of World War II, the unleashing of atomic energy, will have great peacetime benefits. Those aspects of atomic energy which can be made openly available to our overall technical skill and competitive enterprise will make the most rapid strides.

Practical applications of atomic science are already apparent in two main directions: (1) atomic energy for useful power and (2) atomic energy for the production of man-made radioactive forms of atoms, called radioisotopes, which have already found wide use in many important fields of research, in medical treatment, and in industrial technology.

In the case of atomic power the primary question is when will development be far enough along to permit its wide-scale use. Answers to this question usually range from 10 to 25 years depending on the in-

dividual making the prediction. When atomic power does become available for use—and there is little doubt that it will—it will supplement rather than take the place of other forms of power such as now come from coal and water. It is believed that atomic power reactors will prove valuable and economical for use in regions where other types of power cannot be made easily available such as in underdeveloped, remotely located or arid areas.

Benefits from the other main peacetime development of atomic energy, the production of large quantities of radioisotopes, are already here and many more are on the way. These atomic energy-produced atoms have already been used in research studies aimed at increasing the efficiency of fertilizers, eliminating animal and plant diseases, increasing the efficiency of industrial processes, adding to general human knowledge, and controlling the diseases of human beings.

Although the use of radioisotopes is to be discussed in detail by other speakers* at this meeting, I would like to pause here just long enough to give you a bird's-eye view of the variety of applications found for these wondrous atoms.

In science, in life studies ranging from anatomy to zoology and in all the physical sciences, radioisotopes have been used as "tracer atoms"—atoms that can be followed with extreme sensitivity and specificity—to study the behavior and role of atoms in complicated reactions and processes. In investigations of animal and plant physiology, radioisotopes as tracer atoms have proved to be an extremely valuable tool for studying metabolism. One of the most important and long range applications of radioisotopes has been for studying the mechanism of photosynthesis. You will recall that this is the little understood process by which green plants convert carbon dioxide and water with the aid of sunlight into carbohydrate plant food. All life on earth depends directly or indirectly on this process of using the sun's energy.

In medicine radioisotopes have been used in tracing the complicated processes of the body, for example, in tracing how various kinds of food are used for energy and for building blood, bones, muscle and other body tissues—the details of how powerful biochemical agents, such as hormones, vitamins and enzymes, regulate and promote essential body processes—the method by which the body combats disease with its own internally produced chemicals, the antibodies—

* "Radioisotopes in Biology"—Dr. N. H. Woodruff, Assistant Chief, Isotopes Division, Oak Ridge Operations, U.S. A.E.C., Oak Ridge, Tennessee.

"Applications of Atomic Energy to the Biological Sciences"—Dr. Norbert J. Scully, Argonne National Laboratories, University of Chicago, Chicago, Ill.

"Radioisotopes in Research"—Dr. Karl Lark-Horovitz, Purdue University, Lafayette, Indiana.

and the mechanism by which various drugs such as sulfa drugs and penicillin help you to overcome infections.

In addition some radioisotopes are being used in hospitals and clinics for diagnosing and treating certain diseased conditions. Radioactive iodine is being used to diagnose and treat certain types of overactive thyroid gland conditions and thyroid cancer. This same radioisotope when incorporated in a special kind of dye is being used to locate brain tumors. Radioactive phosphorus is being used to treat polycythemia and chronic leukemia. Radiosodium is being used to determine the rate of blood flow and the pumping action of the heart. And radiocobalt is now beginning to be used as a substitute for radium as interstitial and external sources of radiation for treating accessible cancers.

In agriculture radioisotopes have been found particularly useful for studying the utilization of phosphate fertilizers by various crops under varying conditions of soil, climate, and fertilizing techniques. Radiotracers have also been used to study methods of insect pest control and mineral metabolism in cattle.

Industry has found radioactive tracer atoms useful for studying such things as diffusion, polymerization, catalysis, corrosion, vulcanization, detergency, etc. Radioisotopes have also been used simply as sources of radiation in industrial control devices such as thickness and height gauges and in radiographic testing.

I have only very briefly scanned some of the ways in which radioisotopes, one of the byproducts of atomic energy, have been used for the betterment of our material welfare. Greater benefits from these and similar studies are on the way—benefits which will be even more instrumental in raising our standard of living, in eliminating misery and disease and in generally improving our well being.

Let me hasten to say, however, that atomic energy isn't suddenly going to bring forth an utopian world of "milk and honey." It will only be a part—even though a most important one—of our over-all technical advance. Furthermore, there are factors outside the realm of the scientific and technical—factors having to do with moral and political advancement—which will have an important influence on the over-all scheme of things. And besides, history has shown that the development of science and technology, though unpredictable, is methodical. It follows a course of evolution, not revolution.

Another important reason for believing that atomic energy, and indeed all science, will flourish for more and better things to come is unprecedented public appreciation and support of science and technology. People both in this country and elsewhere are becoming more science conscious. They now recognize as never before the great

power of science for both constructive and destructive purposes.

This high public interest affords unprecedented opportunities. It also implies a great public trust—and this means great responsibility for scientists. Furthermore, the scientist now sees that as a nation we have tremendously increased national and international responsibilities. The scientist thus faces new responsibilities outside as well as inside the laboratory.

No longer is the scientist a "long-haired," "ivory-tower" isolationist—a person detached from the world whose main function is to sit and think. Scientists of course need periods of detachment and we hope they do sit and think. But there are few geniuses who can exert all their thinking to ideas and discoveries in fundamental science. The scientist has come to realize, as Atomic Energy Commissioner H. D. Smyth said recently, "there isn't anything necessarily degrading about being useful."

In fact, the experience of large war time projects and industry has shown that close cooperation between technological laboratories and academic research laboratories—between engineers or technologists and scientists—results in a very productive mutual stimulation. As long as all parties recognize the danger of overemphasizing applied research or of restricting scientific exploration—as is becoming increasingly recognized—science will progress more rapidly in the exhilarating atmosphere of being useful and beneficial to mankind.

The scientist has also come to realize that there is much more to human welfare than material welfare. The scientist now appreciates more than ever before that along with increasing scientific, technical and material progress we have an urgent need for political, social, and moral progress.

Let us then turn to these non-material aspects.

DEMOCRACY

True and basic science follows no political ideologies or tenets. Rigorously defined it is merely a passionate search for knowledge and the urge to apply it. Science is free opportunity for unrelenting search for truth. Science must be unbiased, open-minded and based on the principles of fair play. For these reasons science is fundamentally humanitarian. It is this spirit of science which, by elimination of ignorance and fear through knowledge, has been fundamental to advancing man above the animal level.

Science also seeks order—the order of the universe. Indeed, science is the search for knowledge of this order and the use of the knowledge gained to counteract prejudice and fear—to help mankind gain control over his environment.

The course of science is not perfect, however—it makes mistakes. Because it is a search into the unknown, it is based on a trial and error approach. The mistakes inherent in such a process are not important—what is important is that a free science has the adaptability to change its course and correct these mistakes.

From this brief review of the inner workings of science and its methods, it immediately becomes obvious that our free democracy better than other political systems has the wherewithal and proper outlook to further the aims of science. True democracy like science is based on freedom of opportunity and enterprise, equal rights, and the respect for the integrity and beliefs of the individual. Democracy like science is also empirical and it is also subject to human errors or mistakes. But its freedoms also insure the adaptability to correct mistakes.

I wish to emphasize this factor of adaptability. In science it is easy to detect error and if any matter is questioned it can usually be put to rigorous test and the questions can generally be satisfactorily answered. This means that the great majority of specialists on a particular matter will accept the answer regardless of previously held theories or beliefs. Those who may not still believe the answer have the opportunity to make rigorous tests to prove it otherwise. In science therefore there is generally quick adaptability to the facts of a situation or problem.

In social relationships—in government—questions and problems cannot usually be put to rigorous test. Even when certain tests are made, or take place naturally, the testing process is slow and the results may be open to quite different interpretations. Even if the unpredictable variables of human emotions did not enter—even if adaptability were based on factual reasoning alone, the adaptability to social and political situations is inherently slower and less certain than is true for purely scientific and technical matters.

In theory, social and political questions could best be answered by a single person, or small group of persons, chosen for remarkable amounts of knowledge and superior intelligence. Decisions might then be made rapidly and with certainty. This would in turn permit the most rapid and suitable adaptability of a social group or a government to changing conditions. This is the theory of dictatorships or totalitarian governments.

Our government was embarked on a different principle—on the principle that government is “of the people, by the people, and for the people,” and this means all the people, regardless of their store of knowledge, their I.Q., their race, or their creed. It is based on the principle that the best judge of what the people need and want is the

majority of all the people. It is based on the belief that the majority will also have sincere interest in and sufficient compassion for the needs and wants of the minority to see that the minority does not unduly suffer.

In spite of the fact that our government and our people have risen to world leadership by nearly every material and non-material standard, there are those who do not believe our system of government is basically sound. They evidently do not have faith in the average human being, faith in the over-all intelligence of the majority of the people to arrive at the best solution of their mutual problems. They believe in complete paternalism—a "papa knows best attitude"—the all-wise benevolent ruler theory. They believe our system will eventually fail. To prove that they are wrong we will have to "test" our way of government again and again. One would suppose that we had already many times over met the most rigorous tests—in trying political situations, in difficult social problems, in severe financial difficulties, in civil war and in local and global wars.

Yet we must realize that situations are always changing and everything is always under test. Our freedoms and our way of life—which are unusual privileges—are never won; they are only a trust. We must continually remind ourselves that the freedoms, rights and opportunities should be cherished and guarded as a trust. Privilege or liberty, as Jefferson said, cannot be completely inherited, but "must be won anew for every issue in every generation."

In short, science, with its accent on freedom, opportunity and the search for truth, has flourished within our democracy. Furthermore, the relationship between science and democracy has been mutually fruitful. This has been a rapidly changing, dynamic relationship, but science and democracy are geared for the dynamic.

But now a new, potent and unique offspring of science—atomic energy—has entered this relationship.

How will atomic energy function in our democracy? Will our democracy be altered by atomic energy?

These are of course difficult questions and we cannot now expect unequivocal answers. Let us look at the situation.

First, atomic energy within this country is a government monopoly. This is not the usual way in which our government fosters the development of a great new field, a great new industry.

Next, it is not only a monopoly but in many aspects it is a secret monopoly—that is, many operations of the atomic energy program are not completely explained to the public. This also is not our usual way of conducting a government agency or a government function.

Yet, the way the government fosters and develops atomic energy

will profoundly influence our whole future. Decisions on atomic energy matters made in secret and not made known in any way to our people can affect the course of our nation and the world.

This is not just a question of setting a dangerous precedent in our government's way of doing business, but if it is not the best way of handling atomic energy it would be dangerous to our national security.

Congress realized the seriousness of these matters when at the end of the war it was suddenly confronted with what to do about atomic energy. It held open hearings on how we should handle this powerful new force. It listened to scientists and authorities in every field. It debated long and hard, and took a year to make up its mind.

Finally, as representing the people's over-all best judgment Congress passed the Atomic Energy Act of 1946 (McMahon Act). This act set up a civilian agency, the United States Atomic Energy Commission, in the executive branch of the government, directly answerable to the President, with broad powers for fostering, directing and controlling all our atomic energy developments.

The Congress did not pass the act without certain reservations with regard to the future. In the Declaration of Policy of the Act it is stated "The effect of the use of atomic energy for civilian purposes upon the social, economic and political structures of today cannot now be determined. It is a field in which unknown factors are involved. Therefore, any legislation will necessarily be subject to revision from time to time." In other words our democratically minded lawmakers were well aware that laws cannot long be static. They know that our democracy must be prepared for the very rapid adaptability necessary in this rapidly developing field.

The Act was designed to permit insofar as possible the systems of checks and balances between various branches of our government that we employ in other government activities.

It was not practical for the whole Congress to act as "watchdog" over all atomic energy activities. The Act therefore set up a special Joint Congressional Committee on Atomic Energy to have access to information on all atomic energy matters and to watch over for the American public the policies and progress of the Atomic Energy Commission. This is a most essential safeguard.

The Act also established an effective liaison with all the Armed Services through a Military Liaison Committee. It also provides for the highest level professional advice through a General Advisory Committee. Many of the Commission's activities are also subject to regulations and controls of other federal agencies in regard to budgets, finance, personnel policies, legal matters, etc. Thus the Com-

mission is not entirely free to go its own way—nor would it want to be.

Actually, the Commission has had uppermost in its mind from the beginning, not only the tremendous importance of its scientific and technical activities, but the importance of viewing all its activities with reference to our principles of government and way of life.

First, the Commission has repeatedly emphasized that in our democracy the atomic energy project in a very real sense belongs to the American people and they are in a large measure responsible for its proper operation and development. This includes all of you here—you are paying for it, your future will be greatly influenced by it, and you have a voice in how it is to be handled.

It is of course fundamental to such responsibility that the people become adequately and correctly informed. It has repeatedly been made clear that, although some things about atomic energy and the project are necessarily kept secret, information is freely available on most of the basic facts about atomic energy as well as on the basic operations and objectives. Ample information is available to form sound judgments on the proper handling of practically all phases of atomic energy activities. Furthermore, in view of the announced atomic energy developments in Russia, there is without doubt still further information valuable to the American people which is now restricted but which can be released without loss of security.

It has also been emphasized that the facts about atomic energy and its applications which are essential to understanding the problems of its development and control are not too technical for the average citizen. Through its program of education, both public and technical, the Commission has made a real effort to familiarize our people in atomic energy matters. Complete dissemination of the information available, however, requires the active interest and participation of our educational system and all media of public education.

Although the Commission has by law complete control over atomic energy development, it has endeavored to encourage the participation of free enterprise in as many of its activities as possible. All of its plant and laboratory operations are carried out by contracts with private firms and institutions. Those developments arising from atomic energy which do not require security restrictions have been made accessible to free competitive enterprise for further development.

Materials and information that can be released from security restrictions have been made available for useful applications in science, medicine, agriculture and industry. Foremost of the useful materials are the radioisotopes, thousands of shipments of which have been

made for peacetime applications throughout this country and 22 nations abroad. Also thousands of documents concerning work performed in atomic energy laboratories have been carefully reviewed and released for publication in scientific and technical journals.

The Commission thus views the atomic energy project as a valued trust of the American people. From personal and close observation of the whole atomic energy development from before the war, through the war and since the war, I am confident that the Commission appreciates to the fullest extent the magnitude of this trust and has done its utmost to fulfill its responsibilities. It does however need the continued interest and assistance of all its "stockholders"—you and all the rest of the American public.

But you and all the "stockholders" must keep in mind the broad relationships between atomic energy and the basic principles of democracy. Atomic energy must be viewed as a constant reminder for us to examine our fundamental beliefs in the proper social and moral relationships between people.

This leads us to consider these relationships in more detail.

RELIGION

The relationship between science and religion—and I use the word religion in the broad sense of fundamental beliefs and moral values—is not an easy subject to discuss.

Any intelligent discussion of the subject should, I believe, start out on the premise that there is no basic incompatibility between science and religion. Science attempts to explain the "how" of things—religion the "why."

Both science and religion have this in common: they are based on a faith in order. Science seeks and does find order in all things. From the nucleus of the atom, to the living cell, to man, to the galactic nebulae, science has found a definite and orderly scheme of things. From its findings science has been able to increase its knowledge of the way in which the various pieces fit into the pattern of life and the universe. Science cannot, however, even with all the physical and scientific powers at its command explain the "why" of the pattern. This comes within the realm of a higher order of things which religion can best explain.

The criticism of science in its relationship with religion stems not so much from a difference in fundamental concepts as from the fact that science places primary emphasis on material values. Such a course of action is logical to the scientist because he realizes that the "why" of things is beyond the scope of the scientific method and in his quest for knowledge he dwells on the "how" of things—and hence, to the material side.

As science has pushed forward, there has been an increasing emphasis on the material advantages which science can provide, with an apparent lack of attention to moral and social advances. History shows that the rate of material advance has invariably been greater than the rate of advance in moral and social standards. But history also shows that as man has met more and increasingly powerful forces which he did not fully understand, he has increasingly searched for spiritual support—for something that would raise him above the basic animal reactions, above fear and primitive instincts.

Can science be justly criticized for the course of action which it has taken? I think not.

It must be remembered that science is neither good nor bad in itself, but only in the applications that men make of its findings. Furthermore, science is not responsible for the lag between scientific advances and moral advances. This of course does not completely absolve science of the criticism made against it nor does it free the scientist as well as other citizens from their responsibility of trying to promote social, moral and spiritual progress.

Religious leaders need to recognize the demands that a fast changing world has placed on religious teaching. Although no compromises need be made in the basic principles of religion, methods of teaching in religion, as in all subjects, must be adaptable to changing situations. Further, our faiths must be dynamic to keep us in social and moral pace with the modern technological pace.

The need for more emphasis on social and moral advance has been forcefully brought to our attention by suddenly being faced with the possibility of atomic warfare. Scientists and many other persons, had even before the last war, begun to decry the fact that scientists were not sufficiently cognizant of the moral and social consequences of their discoveries and achievements. An important asset on the credit side of the atomic bomb is that it has resulted in an over-all awakening of scientists—to the realization that they must give more and more consideration to promoting advances in social science and in over-all human relationships. Indeed, atomic energy is such a vital factor in world relationships that it makes us examine our basic beliefs as governments and finally, what is more important, our fundamental beliefs as individuals.

It is clear that our responsibilities to ourselves and to the world go much further than continuing our quest for material security. Being the country of the greatest material strength, the world looks to us for leadership and guidance in other matters—in establishing social and moral patterns. Also our true strength does not lie in material strength or as Mr. David E. Lilienthal has said, "We will be misled into believing that America is strong because of military force

alone, when in truth the foundation of our strength and amazing vitality is not in material things but rather in the spirit of this nation, in the faiths we cherish.

"We are a people with a faith in each other—and when we lose that faith we are weak, however heavily armed. We are a people with a faith in reason, and the unending pursuit of new knowledge; and when we lose that faith we are insecure, however heavily armed. We are a people with a faith in God, with a deep sense of stewardship to our Creator, the Father of us all; and when that is no longer strong within us we are weak and we are lost, however heavily armed with weapons—even with atomic weapons—we may be."

EDUCATION

Finally in turning to the educational implications of the previous remarks, I want to say at the outset that I am not an educator. My remarks may be of interest to you, however, in that they will be from the outside looking in rather than from the inside looking out.

As society has become more and more alert and ambitious in the exploitation of scientific developments, the time lag between technological advance and its social influences has become increasingly shorter. The mushrooming of atomic energy from a laboratory curiosity into a world-shaking force inside of a few years stands out as one of the most striking examples of the speed and importance of the social consequences of science.

Before the war we could teach atomic, or rather nuclear, science as we would any other part of the scientific curriculum, that is, in terms of scientific fact only. The atomic bomb has altered this. The atomic bomb became a signal for more social consciousness in the teaching of science—and even further, in all teaching.

When we begin to analyze the educational task brought on by the development of atomic energy, we find that the problems confronting us are not directly those of science and technology. Rather, as noted before, they are some of the most fundamental problems of society. We come face to face with the basic issues of what is right and what is wrong in human relationships—not just among the peoples of this nation but of the world. These issues are social, political and moral. Their analysis takes us back to our fundamental beliefs—that is, to our philosophy, our tenets of government, and our religion.

Truly, our educational job goes much deeper than the facts and issues connected with atomic energy. Recognition needs to be taken of some of the deepest, most basic concerns of people as individuals.

It seems to me that the foremost educational problem today is to find a way to give to students as well as to the people of the nation as a whole more of a sense of values and of purpose. Never before has

this problem been as important. Not only is it important because rapidly changing events in the world of science have made it so, but also because of rapidly changing moral and political situations.

Without question the greatest competition in the world today is for the minds of men. The magnitude and seriousness of this competition cannot be overemphasized. Conflicting ideologies are continually striving to strengthen their forces by enlisting the youth of our country and of the world.

To cope with this situation I would suggest that we make a special effort to supplement our education, which in the past has been regarded largely in terms of the three R's—"readin', 'ritin', and 'rithmetic," with two other R's. These are reason and relationships—human relationships.

The student should be taught the value and power of free, unbiased and unemotional reason—reason which is adaptable to facts rather than to personal desires, ambitions and emotions—reason that is not influenced by "wishful thinking." On the other hand the student should be taught the relationships between human beings, from the basic person to person relationships to relationships between nations. And finally he must be taught to realize that in many cases human emotions and relationships weigh more heavily than pure reason—and that in almost any situation a fine balance must be achieved between the two.

Acceptance of the educational challenge brought on by developments in science and atomic energy means that educators must give serious thought to the questions of how and to what extent can the schools and colleges further increase their contribution to the social, political and moral consciousness of the students—and in fact to the population as a whole.

Not being an educator I will not attempt to answer this very large and difficult question. As science teachers I know that you have more specific questions: How, where in the curriculum, and to what extent should there be teaching of the social, political and moral consequences of science? And even more specific still is the same question applied to atomic energy.

It would be foolish for me or any of us to try to present nice neat solutions of the problems confronting us. Firstly, none of us are all-wise Solomons on all phases of all the issues and, secondly, there is little that long remains "status quo" in our dynamic world of today.

What we can give students, however, is the ability to make decisions that will result in wise and satisfactory solutions—and the ability to alter solutions to fit changing situations. In the case of the fourth R, reason, the teacher can give the wherewithal to form honest

unbiased opinions on the basis of all the facts available. Although the teacher cannot directly aid the student in reasoning out every situation which will arise, he can instruct the student in the methods of reasoning and show him how the power of reason can be used in reaching an unbiased solution.

First, you can assemble all the facts and truths pertinent to the subject or issue. Then you can reduce them to those that are essential to a complete picture and present them in as simply understandable form as possible.

Second, your presentation must have interest and appeal. The facts should be tied in with the student's or the individual's own life or experiences. It should be made clear wherein he may be favorably and adversely affected by the way he and others handle the problem.

Third, you can attempt to interpret the facts and to give meanings when necessary.

Fourth, you can illustrate correct thinking by showing alternate, interpretations or solutions—that is, to show unbiased yet disciplined thinking—a tolerance and open-mindedness toward other opinions yet a strength of conviction for what truly appears right. The teacher should use democratic principles in his teaching by gathering all the facts, discussing all sides and arbitrating the various opinions advanced. Indeed, the teacher should invite and encourage honest questioning of authority—not from the point of view of encouraging the student to become “cocky” in his attitude but to become genuinely and constructively critical in his analysis of a particular situation.

Fifth, you can illustrate the balancing of factors that comes into making judgments—the gains and losses involved, both immediate and long range—and the moral values involved in making the judgments.

Sixth, you can indicate ways in which our democratically formed opinions and judgments may be carried into action.

I am sure that you know all this, but what I mean is that the science teacher or instructor can do more than anyone to show correct ways of reasoning through a whole set of complicated facts and observations.

Another thing that the science teacher can do is illustrated in Dr. Conant's book, *Understanding Science*. Certainly, we do not want to make scientists out of every high school student, but we can give each and every one of them an understanding of the scientific method. This can be illustrated by carrying through the history of certain scientific developments. They should be taught to see that science is not just a body of facts—or even a method. It is part of the fundamental urge of man to know and to create—to become fa-

miliar and unfearful of his world and to apply the knowledge to human betterment.

The student should also be reminded that education does not involve merely the learning of a group of subjects. Education goes much further than this. In the broader sense education is preparing youth to accept the responsibilities which will make him a valuable member of our society. You of course know this but I don't believe the average student knows it. My point is that he should.

The teacher can do much to help this situation—to broaden the student's outlook. For example, he can teach the student that there is no conflict between science and religion and show him why. In discussing government the student should be taught that democracy is more than a president and a congress elected by the people—that it is a political system based on the fundamental beliefs of a free people—a system which has been tried and tested and found to work for the best interests of all. In other words my recommendation is that in our teaching we add emphasis to the "why's" and "wherefore's" to supplement the emphasis that we have been placing on the "what's" and "hows."

The approach to the fifth R or relationships between people and nations is not as straightforward. In the past, elementary and secondary schools and even the colleges concerned themselves almost exclusively with classical subjects and facts, leaving largely to the home and church the teaching of mental and moral adjustment to society. Although the home and church are still in the main more responsible than the schools for establishing our mental and moral patterns, the technical complexities of our society have tended to diminish their influence and to leave more of this job for the schools and colleges. With the introduction of atomic energy into our lives, there is a further and increasing call for education to help in contributing to the individual's sense of values and of purpose.

The best way of facing this responsibility is not clear. Teachers and the schools are already contributing in certain ways to giving meaning and purpose to life, to establishing a proper reaction to society, to building moral character without specifically entering into the domain of the church.

I think that we should critically review the methods already in practice for teaching these principles with the express intent of strengthening them. With the proper reemphasis of these teaching methods and with a conscientious effort made to teach reason and relationships, we can be hopeful that youth will be able to accept the extra burden of responsibility placed on him by the development of atomic energy.

CONCLUSION

I have tried to give you some of my ideas about how atomic energy fits into our way of life. Atomic energy has both its good and bad side. The question as to which of these will predominate in our future is not dependent on progress in atomic energy—not dependent on progress in science—but dependent on progress in man himself.

Dr. Arthur Compton, one of our leading scientists has summed it up like this:

"The release of atomic energy is merely the most recent important step of that steady progression of science that is compelling man to become more human. He must pay careful attention to cooperation, education, and service for the welfare of society if he is to thrive under the conditions that science imposes. If we will let ourselves grow as thus indicated, the civilization of the atomic age promises to be the richest that history has known, not only with regard to material bounty, but also in its cultivation and appreciation of the truest human values."

In closing I would like to quote from one of the poignant and timely prayers with which the late Rev. Peter Marshall, as chaplain of the United States Senate used to open the Senate's daily sessions:

"Oh! God, our Father, let us not be content to wait and see what will happen, but give us the determination to make the right things happen.

"While time is running out, save us from patience which is akin to cowardice.

"Give us the courage to be either hot or cold, to stand for something, lest we fall for anything."

That is what is meant by dynamic faith—the faith and determination to make the right things happen—to stand for something, lest we fall for anything.

As scientists and educators we must continually renew our courage to stand for—and teach for—what we believe to be best not only in science and education, but in our way of life and in the relationships between men and nations.

The Central Association of Science and Mathematics Teachers is one of the oldest organizations for science or mathematics teachers in the United States. Read *A Half Century of Teaching Science and Mathematics*, published to commemorate its fiftieth anniversary.

Discovery of fossils of ancient shark spines in South America set back the estimated age of rock formations by 100,000,000 years.

Fourteen nations in the Middle East and Southeast Asia have accepted invitations to send student delegates to the fifth annual *New York Herald Tribune* Forum for High Schools

The delegates arrived late in December for a 10-weeks visit to this country, climaxed by their appearance as speakers at the forum March 4. They will be the guests of American high school students and their families, moving to different communities every two weeks.

CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS

REPORT OF THE CHICAGO MEETING

The meeting of the Board of Directors of the Central Association of Science and Mathematics Teachers was held in the American Room of the Edgewater Beach Hotel, Chicago, Illinois, on November 24, 1949.

The meeting was called to order at 7:50 P.M. by the president, Dr. Charlotte Grant. The following officers and Board members were present:

Charlotte Grant	Glen W. Warner	Philip Tapley
Arthur C. Brookley	Paul L. Trump	Raymond Agren
Ralph W. Lefler	Martha E. Curtis	Cecilia J. Lauby
F. Olin Capps	Donald W. Lentz	Philip Peak
Ray C. Soliday	Ella Marth	Loren M. McKenzie
Mary A. Potter	Edwin W. Schreiber	Walter N. Smith
H. Vernon Price		

Others in attendance were:

Arthur O. Baker	Walter Gingery	Milton D. Oestreicher
Walter H. Carnahan	Fred D. Leonard	John E. Potzger

Mr. Milton D. Oestreicher, general coordinator of local arrangements committees, gave a report on the progress and plans which had been made and completed for the Convention. The banquet was well planned; it was to be followed by a general mixer. The exhibits by students were being revived this year. These exhibits were located in the balcony of the Ball Room. Arrangements had been made so that only those individuals who had lapel cards were admitted to the meetings.

Mr. Joseph E. Dickham, chairman of the publicity committee, sent a written report of the activities of his committee. President Grant presented this report to the Board and complimented the committee on its splendid work.

The Board informally agreed that the local committees had been very faithful and had worked diligently to secure a successful convention. The Board expressed its appreciation for the splendid work of all these individuals and complimented them for their excellent cooperation.

President Grant called attention to the new schedule of meetings which had been adopted for this Convention. In many instances the time between meetings was short and this would necessitate everyone's conforming as closely as possible to the times which had been allotted for the meetings.

Mr. Arthur O. Baker, CASMT representative on the AAAS Cooperative Committee on the Teaching of Science and Mathematics, presented a written report of the meeting of this Committee which was held in Chicago, October 1-2, 1949. Mr. Baker stated that this Cooperative Committee would like to be informed about other research projects which are being conducted by various organizations. Science in General Education at the College Level is to be the topic of discussion at the New York meeting, December 27-29, 1949. Mr. Baker informed the Board of Directors of CASMT of the fact that Dr. Lark-Horovitz is resigning as chairman of the Cooperative Committee. He has been a masterful director.

Mr. Roy Agren, chairman of the *Yearbook*, reported that the *Yearbook* affairs were in good standing. Financially it appears that the Association will make a profit of near two hundred dollars. Mr. Agren pointed out the need for having someone responsible for the finances of the *Yearbook*. A discussion followed as to the best procedures which might be employed to handle the financial matters concerning the *Yearbook*.

Mr. Trump moved, Mr. Smith seconded the motion, and it was passed that the financial matters of the *Yearbook* be handled through the Treasurer of the Association and that these financial accounts be kept in his office, and further-

more, that the budget of the Association be revised or amended so as to take care of the financial matters concerning the *Yearbook*.

Mr. Smith moved, Mr. Brookley seconded, and it was passed that next year's budget be compiled so that the financial matters concerning the *Yearbook* are included.

There was general agreement among the Board that the *Yearbook* had been well managed this year and the Board informally expressed its appreciation to Mr. Agren for his splendid work.

The report of the Journal Committee was made by the chairman, Mr. Walter Gingery, who stated that the audits show a continual increase in the net worth of the Association. Mr. Smith was asked to substitute for Mr. Vordenburg at the meetings of the Journal Committee during the Convention. Mr. Vordenburg was unable to attend the Annual Convention of CASMT this year.

Mr. Ray Soliday, Treasurer of CASMT, reported that there is one hundred dollars less in the bank this year than a year ago. However, the Association has materials—stamped envelopes, etc.—on hand which would account for the differences. The subscriptions to the *Journal*, *SCHOOL SCIENCE AND MATHEMATICS*, were greater than had been anticipated, but the advertising was below expectations. Printing costs are still high.

The Board discussed the value of the profit and loss statement as giving a clear picture of the financial status of the Association. A discussion of the auditor's report followed. The suggestion was made that a balance sheet might be more understandable to the members of the Board than a profit and loss statement. The Board informally agreed that the Treasurer decide what kind of a report could be submitted that would present best the financial status of the Association to the Board of Directors.

Dr. Glen Warner, editor of *SCHOOL SCIENCE AND MATHEMATICS*, reported on Journal affairs from the editor's viewpoint. He again called attention to his new address, Lakeville, Indiana. The Journal will have a gold cover next year to commemorate the 50th Anniversary of the Association. Dr. Warner would appreciate having the Board members contact famous scientists and mathematicians in order to secure articles of unusual high value for publication in the Journal.

Mr. Fred Leonhard, chairman of the Membership Committee, gave a report on the present membership of the Association. As of November 20, 1949, CASMT has 1044 members; one year ago the membership at this time was 1061. Mr. Leonhard also reported on the representation of the various fields—biology, chemistry, etc.—among the membership. He also gave a comparison of the number of members from various states as shown in 1945 and 1947 with the membership from those states as it exists in 1949.

Dr. Paul Trump, chairman of the Resolutions and Policy Committee, asked that the report of his Committee be postponed until the Saturday afternoon meeting of the Board of Directors. Attention was called to the fact that Dr. Trump was to make a brief report to the Association at the General Session on Saturday morning relative to the work of the Policy Projects Committees.

Dr. Walter Carnahan, editor-in-chief of the Anniversary Publication, reported that work was progressing in good order; much of the ground work had been laid and all indications pointed to the Anniversary Publication's being completed on schedule. A written report was submitted to the Board on the present status of the writing which is to make up the Publication.

Dr. J. E. Potzger, chairman of the Publicity and Promotion Committee of the Anniversary Publication, gave a report of the plans which had been made for the coming year. These plans included, among other things, advertising and notices in the Journal. A display calling attention to the Anniversary Publication was placed next to the membership desk. Gold seals had been designed and made by the Art Department and the Printing Shop of the George Washington High School, Indianapolis, Indiana. These seals were on sale at the convention. Dr. Potzger moved, Mr. Peak seconded, and it was passed that the gold seals be

sold at the price of two packages for twenty-five cents.

Dr. Trump moved, Miss Marth seconded, and the motion carried that the Secretary of CASMT write a letter to the Art Department and Printing Shop of the George Washington High School which expressed the sincere thanks and appreciation of the Board of Directors of CASMT for the work of these departments in designing and making these gold seals.

The returns which would result from advertising the Anniversary Publication in journals other than *SCHOOL SCIENCE AND MATHEMATICS* were discussed. Dr. Potzger told the Board about an advertising booklet which his committee had completed in time to be used at this Convention. He also suggested that this booklet could be mailed to members of the Association. Mr. Schreiber moved and Dr. Potzger seconded the motion that the Publicity and Promotion Committee of the Anniversary Publication decide how the booklets were to be distributed. The motion carried. An amendment to this motion was made by Mr. Smith and seconded by Mr. Brookley. The amendment stated that if these advertising booklets were distributed by the Treasurer of the Association, the Treasurer should receive compensation for this extra work. The amendment passed.

Mr. Ralph Lefler reported that one of the publishing companies was mailing, at its own expense, copies of the program of the AAAS Teaching Societies meeting in New York on December 27 through December 29. Space on the mezzanine floor of the Hotel New Yorker had been provided for the use of CASMT during the time of these AAAS meetings.

Mr. Edwin Schreiber, historian, reported that Mrs. Ruth Miksell died on October 16, 1949.

President Grant informed the Board that the Geography Section had requested that any action regarding the status of the Geography Section be delayed until after the Section had met on Friday.

President Grant called the attention of those present to the fact that the revision of the By-Laws would be up for vote at the Business Session of CASMT on Saturday morning. Dr. Grant also reminded those present of the Board of Directors meeting on Saturday afternoon at 1:30 P.M. in the American Room. This meeting is for both old and new members of the Board of Directors.

The meeting adjourned at 10:45 P.M.

SATURDAY MORNING BUSINESS MEETING

President Grant called the meeting to order at 8:40 A.M. Saturday, November 26, 1949, in the Ball Room of the Edgewater Beach Hotel.

Attention was called to the student exhibits which have been displayed in the balcony of the Ball Room, Mr. Lefler stated that student exhibits should be encouraged. Mr. Tapley commented that such exhibits could be a device for increasing membership in the Association. Mr. Oestricher commented on the fact that if student exhibits were to be encouraged at future conventions of CASMT, work on the project must start early in the year and care should be exercised so as to present these exhibit is from becoming unwieldy. Some attempt at selection should be made.

Mr. Soliday commented that registration was much more successful this year than it had been at previous Conventions. He felt that all members of the Association should make the guests who attended this convention feel welcome and let them know that we would be happy to have them as regular members of the Association.

Mr. Gingery, chairman of the Journal Committee, announced that Frank B. Wade had been made an Emeritus member of CASMT. Mr. Wade recently retired from teaching at Shortridge High School, Indianapolis, Indiana; he has held a continuous membership in CASMT for twenty-eight years.

Dr. Warner, chairman of the Necrology Committee, reported that Mr. Frank E. Goodell of Iowa died approximately two years ago, but Dr. Warner had been notified of his death only recently. Mrs. Ruth Miksell died October 16, 1949.

With reference to the Journal, *SCHOOL SCIENCE AND MATHEMATICS*, Dr.

Warner hopes that the 1950 Journal will be the best we have ever had. He asked that more high grade papers be sent in for publication.

Dr. Walter Carnahan, editor-in-chief of the Anniversary Publication, reported that good progress was being made and that the work would be one of which all could be proud.

Dr. Potzger, chairman of the Publicity and Promotions Committee of the Anniversary Publication, told about the miniature booklets and gold seals which had been designed and made by the Art Department and the Printing Shop of the George Washington High School at Indianapolis. These booklets and seals were to be used to advertise the Anniversary Publication. Articles were planned for each issue of the Journal during 1950. Order blanks for the Anniversary Publication can be secured after the meeting. The prepublication price is \$2.50; the regular price is \$3.00. Dr. Potzger moved, Mr. Brookley seconded the motion and it was passed that a vote of thanks be extended to the Art Department and the Printing Shop at the George Washington High School, Indianapolis, Indiana, for the interest and work which they had done for the Association and for the money which their efforts had saved the Association.

Mr. Ralph Lefler announced that meetings of the AAAS Cooperative Societies for the Teaching of Science and Mathematics would be held in New York City December 27-29 in the Hotel New Yorker. The programs of these meetings will be sent to the membership of CASMT through the courtesy of the Welsh Company.

The place of meeting for the 1950 Annual Convention of the Central Association of Science and Mathematics Teachers will be in Chicago, Illinois.

Mr. Teeters, chairman of the Nominating Committee presented for consideration the following slate of officers for 1949-50.

President: Paul L. Trump, University of Madison, Madison, Wisconsin.

Vice President: Allen F. Meyer, Mackenzie High School, Detroit, Michigan.

Board of Directors whose terms expire in 1952:

John E. Habat, Euclid Shore Junior H.S., Euclid, Ohio.
Edgar S. Leach, Evanston Township H.S., Evanston, Ill.
Milton O. Pella, University High School, Madison, Wis.
Helen Trowbridge, Glenbard H.S. Glen Ellyn, Ill.

Mr. Teeters moved that the slate be accepted. Mr. Peak seconded the motion. The motion carried.

Dr. Trump expressed his sincere appreciation of the honor and faith the Association had bestowed on him in awarding him this honor during the semi-centennial year. Dr. Trump stated that he hoped to make the coming year one that would be remembered as "extra special" in the annals of CASMT. Dr. Trump readily recognized that the success of the coming year, like those of the past, was dependent upon the cooperation of the membership of the Association. He asked for the support of all.

Mr. Arthur O. Baker, chairman of the Committee on Revision of the By-Laws, presented the revisions in written form. These suggested revisions had previously been printed in the Journal. Mr. Baker moved that the revisions as recommended by the committee be accepted. Mr. Soliday seconded the motion. A discussion of the revisions followed. The motion was lost.

It was moved by Mrs. Wilcox and seconded by Dr. Read that the revisions as recommended in Article I on Members be accepted. The motion carried.

Mr. Peak moved that the revisions as recommended in Section I of Article III be accepted. Mr. Lefler seconded the motion. The motion was lost.

Mr. Tapley moved that the revisions as recommended in all of Article III be accepted. Mr. Schenck seconded the motion. The motion was lost.

Mr. Baker moved and Mr. Gingery seconded the motion that the revisions as recommended in Article IV be accepted. The motion was lost.

Mr. Peak moved and Mrs. Wilcox seconded the motion that the revisions as recommended in Article V be accepted. The motion was lost.

Mr. Lefler moved and Mrs. Wilcox seconded the motion that the grateful appreciation of the Association be extended to the officers and all of those who had cooperated to make this such a successful Convention and that this appreciation be recorded in the minutes. The motion arrived.

The meeting adjourned at 9:45 A.M.

THE SATURDAY AFTERNOON MEETING OF THE BOARD

The meeting of the officers and the Board of Directors was called to order by retiring president, Dr. Charlotte Grant, in the American Room, Saturday, November 26, 1949 at 2:00 P.M. The following were present:

Charlotte Grant	Edwin Schreiber	Allen F. Meyer
Walter Carnahan	Paul L. Trump	Ralph Lefler
Arthur C. Brookley	John E. Habat	Ray C. Soliday
Donald W. Lentz	Martha E. Curtis	Edgar S. Leach
Cecilia J. Lauby	Loren M. McKenzie	Philip Peak
Milton O. Pella	Glen W. Warner	H. Vernon Price
Mary A. Potter	J. E. Potzger	

Remaining as old business was the status of the Geography Section. Miss Laura Watkins, chairman of the Geography Section, was invited into the Board Meeting to express the views of the Geography Section. Miss Watkins informed the Board that it was the wish of the Geography Section to remain a section of CASMT. Plans were underway for the National Council of Geography Teachers to hold its meeting in Chicago in 1950. This council would welcome an invitation from CASMT to cooperate in a joint meeting at this time next year. A discussion of the advisability of a kind of joint cooperation followed.

Mr. Lefler moved that the Executive Committee of CASMT be given the authority to act for the Board in deciding on a cooperative meeting with the National Council of Geography Teachers. The Board suggests that an invitation might be extended to the Council to: (a) meet at the same hotel; (b) honor members of either group at the meetings of both groups; (c) have exhibits along with CASMT; (d) plan a joint general program. It is to be understood that these suggestions are merely guides in the planning of the cooperation, the further and final details are left to the discretion of the Executive Committee. Mr. Peak seconded the motion. The motion carried.

A discussion of student exhibits followed. Dr. Grant mentioned that Mr. Barr, chairman of Student Exhibits, and his committee had worked hard and had endeavored to see that the student exhibitors enjoyed the Convention. Mr. Meyer called attention to the fact that students exhibits were a grand opportunity for publicity for they would tend to spread the influence of the Association. Mr. Lefler thought it was an excellent opportunity for local committees to work with national groups. Mention was made that these student exhibits were good grassroots material and, if written up in the Journal, would be very helpful to many teachers.

Miss Potter moved, Mr. Meyer seconded and it was passed that student exhibits be continued at the annual Convention of CASMT.

Dr. Grant expressed her appreciation for the enormous help and splendid cooperation she had received throughout the year and stated that it was one of the happiest, if busiest, years she had known. She thanked everyone for his wholehearted cooperation and support. She then turned the gavel over to the newly elected president, Dr. Paul L. Trump.

Dr. Trump introduced Mr. Allen Meyer, newly elected Vice President, and the new members of the Board of Directors: Mr. John E. Habat, Mr. Edgar Leach, and Mr. Milton E. Pella. Miss Helen Trowbridge was unable to attend the meeting.

Dr. Trump asked for suggestions as to hotels where the annual convention of

CASMT might be held next year. Some suggested a return to the Edgewater Beach Hotel, others pointed out the advantages of a loop hotel. The decision was left to the Executive Committee.

Dr. Trump recommended the following as members of the Executive Committee, Allen Meyer, Charlotte Grant, H. Vernon Price, together with Mr. Trump. Mr. Brookley moved, Mr. Peak seconded the motion that the membership of the Executive Committee as recommended by Dr. Trump be appointed. The motion carried.

Since the major revisions of the By-Laws as recommended had not been accepted by the Association, it was recommended that the Committee on Revision of the By-Laws continue the study of the by-laws. It was agreed by the Board that the action of the membership of the Association in not accepting some of the proposed revisions was a healthful sign, a condition to be desired. The action of the membership in no way reflected discredit on the work of the Revisions Committee. Several Board members stated that the Committee on the Revisions of the By-Laws requested that their membership be increased so as to give a wider sampling of the viewpoint of the Association.

Mr. Brookley moved and Mr. Lentz seconded the motion that Marie Wilcox, Philip Tapley, Philip Peak, and Bjarne Ullsvik be asked to study the by-laws with the three members of the Committee on the Revision of the By-Laws and that this Committee of seven make recommendations to the Board at the spring meeting. The motion carried.

President Trump called attention to the meeting of the Board of Directors which would be held on the third Saturday in May—May 20, 1950. The place of meeting will be announced later.

Dr. Trump served as chairman of the Policy and Resolutions Committee during the past year. As chairman of the Policy Projects Committee, Dr. Trump presented the following recommendations from the Policy and Resolutions Committee:

1. The Project Committee be responsible for planning and carrying out its projects.
2. The Project Committees be invited to solicit assistance and suggestions from the Policy Committee.
3. That formal presentation should be made by the Project Committees of any matter of policy which involves desired policy action or resolution of the Policy Committee.
4. The Policy Committee should serve in a coordinating capacity concerning the total projects program.
5. New Project Committees may be formed by appointment of the President. Recommendations for such new committees may be made by the Policy Committee.
6. Project Committees are encouraged to publish significant results of their activities in the Journal.
7. In the event that results of special projects merit such reporting, the Policy Committee may consider recommendations to the Board for special publication by the Association.
8. New Project Committee be formed to study ways and means of bringing to the attention of the community the importance of the place of science and mathematics in education.
9. Time and place on the 1950 Convention Program of CASMT be given to Policy Committee reports.

Mr. Warner notified the Board that the Journal needs a new zoology editor. Dr. Warner asked for suggestions for filling the position.

Mr. Peak moved, Mr. Brookley seconded the motion and it passed that the meeting adjourn.

The meeting was adjourned at 3:45 P.M.

The minutes of the three meetings are respectfully submitted.

CECILIA J. LAUBY, *Secretary*

THE SECTION MEETINGS

The various section meetings of the Association held on Friday morning and Friday afternoon, and the Group meetings held on Saturday morning met the high standards established in the general meetings. Officers for the sections were elected in accordance with the by-laws of the Central Association of Science and Mathematics Teachers. The full roster of officers from 1949-50 appears in this issue of the Journal.

CECILIA J. LAUBY, *Secretary*

THE BIOLOGY SECTION

Dr. Robert H. Cooper opened the biology section meeting of the Central Association of Science and Mathematics Teachers at the Edgewater Beach Hotel, Chicago, Illinois. Vice-Chairman, Donald O'Brien and Secretary Frances M. Gourley were introduced.

Dr. Nathan H. Woodruff, Assistant Chief, Isotopes Division, Oak Ridge Operations, United States Atomic Energy Commission, Oak Ridge, Tennessee and Dr. Norbert J. Scully, Argonne National Laboratories, University of Chicago, Chicago, Illinois presented a very interesting program to the groups on the recent research on isotopes and their use in biology.

The meeting closed with the following report of the nominating committee:

Chairman.—Donald O'Brien, Thornton Township High School, Harvey, Illinois.

Vice-Chairman.—Frances M. Gourley, LaPorte Senior High School, LaPorte, Indiana.

Secretary.—Ruby Fremont, Calumet High School, Chicago, Illinois.

FRANCES M. GOURLEY, *Secretary*

THE CHEMISTRY SECTION

The Chemistry Section was called to order in the Michigan Room of the Edgewater Beach Hotel by Chairman Carl E. Ekblad, Senior High School, Moline, Illinois. Approximately fifty members were present.

After preliminary announcements, the chairman introduced, the first speaker, Dr. E. Hill, Augustana College, who spoke on "Sulfonation of organic compounds." After having defined sulfonation, he proceeded to list fourteen sulfonating and sulfating agents. In this list he included sulfur trioxide which can be used in sulfonating both aliphatic and aromatic compounds. He called attention to the fact that the General Chemical Division of the Allied Chemical and Dye Corporation has recently put on the market a stabilized sulfur trioxide in the liquid state under the trade name "Sulfan." Such a product has led to renewed interest in the use of sulfur trioxide as a sulfonating and sulfating agent. Dr. Hill then discussed many reactions in which sulfan proved effective as a sulfonating agent. He emphasized that, in many cases in which sulfuric acid had been used, the reactions gradually ceased because of the formation of water which dilutes the acid. However, no water is formed if sulfur trioxide is used.

The second talk of the morning was given by Dr. W. C. McCrone of Armour Research Foundation, Chicago, Illinois. His subject, "Crystallography," was illustrated with excellent slides.

He first defined crystallography as a study of the size and shape of crystals. Such a study is of importance, because of the formation it gives concerning the structure of matter. Knowing its structure we can then prophecy concerning its properties and uses. He discussed the work of Laue and others who by X-ray analysis were able to show the lattice structures of a great many crystals. Mr. McCrone emphasized that X-ray analysis gives us a wonderful insight into the fundamental make up of solid matter and in turn throws much light upon the properties of matter in the bulk, such as, malleability, ductility, electrical conductance, hardness, solubility, etc. He pointed out that much information concerning the make-up of solid matter could be more easily obtained by chemical micros-

copy than through X-ray analysis. The slides showed various color effects caused by the thickness of the crystal sample. In some cases effective use was made of polarized light in showing the character of crystals.

The final paper of the morning was presented by Mr. H. R. Smith, former Head of the Chemistry Department at Milton College and now an active co-author of the popular high school text—"Chemistry and You." He spoke on "A New Plan for Supplementary Reading Material in Chemistry." He brought to our attention various educational pamphlets that are now available from industrial concerns. He said we could obtain 40 or more copies of each pamphlet. They could thus be given to each student of the class and a definite assignment could be made from such material. He further emphasized the excellent information that was found in these pamphlets—historical information, detailed descriptions with balanced chemical equations of basic industrial processes. A list of the companies furnishing such literature will appear in an early number of *SCHOOL SCIENCE AND MATHEMATICS*.

After the first speaker, Dr. Julian Greenlee of Kalamazoo, chairman of the nominating committee, presented the following candidates for office for the coming year:

Chairman—Mr. Clyde W. Dewalt, Glenbard Twp. High School, Glen Ellyn, Illinois.

Vice-Chairman—Dr. Gerald Osborn, Western Michigan College, Kalamazoo, Michigan.

Secretary—Mr. Sylvan Mikelson, University School, Ohio State University.

A unanimous ballot was cast for these candidates.

GERALD OSBORN, *Secretary*

ELEMENTARY MATHEMATICS SECTION

Miss Esther Cowley, Oakman School, Detroit, Michigan, chairman of the Elementary Mathematics section called the meeting to order at 2:40 P.M. in the Michigan Room of the Edgewater Beach Hotel, Chicago. Miss Cowley introduced the other officers of the section, Vice-Chairman J. R. Mayor, University of Wisconsin, Madison, Wis. and Secretary Mrs. Lucile B. Gates, Sawyer Avenue School, Chicago, Illinois. It was agreed to dispense with the reading of the minutes of the previous meeting.

The chairman appointed the following persons to serve on a nominating committee of section officers:

Mr. Joseph Urbancek, Chicago, Illinois

Mrs. Marie Sperks, Chicago, Illinois

Miss Blossom, Detroit, Michigan

Between the second and third speaker, this committee reported their recommendations for 1950 as follows:

Chairman—J. R. Mayor, Madison, Wisconsin.

Vice-Chairman—Mrs. Lucile B. Gates, Chicago, Illinois.

Secretary—Miss Ella Marth, St. Louis, Missouri.

The report was approved.

Miss Cowley introduced the first speaker, Miss Sara Rodgers, Burnside School, Chicago, Illinois. Miss Rodgers' Topic was "Use of Arithmetic Verbal Problems." She indicated the philosophy and principles involved in the selection of the problems, the technique of giving the lessons and the follow-up. Miss Rodgers called attention to the fact that care should be taken to keep these problems within the experience, interest, and understanding of the pupils and based upon significant social situations.

Mrs. Francesca L. Urbancek, Wells High School, Chicago, Illinois spoke on the subject "The Effective Use of Meaningful Practice Materials in Arithmetic." Mimeographed material was distributed to the audience so attention could be directed to these pages as Mrs. Urbancek referred to the six important principles necessary for developing arithmetical skill.

"An Elementary Supervisor Looks at Arithmetic" was the title of an interesting paper read by Sister Mary Bernadetta, O.P., M.A. Sister Bernadetta stressed the responsibility of teachers of arithmetic to make this subject understandable, interesting, challenging, and socialized—we must guide the child's growth in arithmetic.

According to reliable statistics, there are more failures in arithmetic than in any other school subject. Moreover the further children progress through the grades the greater the difficulty they experience with this subject. There is evidence that weaknesses exist in arithmetical learning in the primary grades. It is in the lower grades that the child develops his attitude toward arithmetic, and forms his habit of thinking of numbers. These habits once formed and then strengthened by use, very largely set the limits of his success in later learning. Growth and progress is dependent upon many factors of which individual pupil ability and the skill of the teacher are the most prominent.

The fourth speaker, Mrs. Marybelle Garrigan, Instructor, Department of Education, De Paul University, Chicago, presented an interesting and amusing paper entitled, "Appreciation and the Young Mathematician," in which she proved her point that numbers have a very important place in the lives of primary grade children. Even at this age they are beginning to be aware of the use of arithmetic as a tool to enrich their personal objective experiences and to help them handle their world.

The meeting adjourned at 4:30 P.M.

LUCILE B. GATES, *Secretary*

THE MATHEMATICS SECTION

The meeting was called to order at 10:40 A.M. by the Chairman, Mr. William H. Edwards, Mumford High School, Detroit, Michigan.

Mr. Edwards introduced the other officers of the section, Vice-chairman E. H. C. Hildebrandt, Northwestern University, Evanston, Illinois, and Secretary Enoch D. Burton, Shortridge High School, Indianapolis, Indiana.

It was agreed to dispense with the reading of the minutes of the previous meeting.

The Chairman appointed the following persons to serve on a nominating committee of section officers.

Mr. W. G. Hendershot, Roosevelt High School, Chicago, Illinois

Mr. Clarence Leonard, Southeastern High School, Detroit, Michigan

Mr. A. M. Welchons, Arsenal Technical Schools, Indianapolis, Indiana

The committee later reported their recommendations for 1950 as follows:

Chairman—Mr. E. H. C. Hildebrandt, Evanston, Illinois.

Vice-Chairman—Mr. E. D. Burton, Indianapolis, Indiana.

Secretary—Miss Virginia Terhune, Proviso Twp. High School, Maywood, Illinois.

This report was approved.

The first speaker on the program was Miss Virginia Terhune, Proviso High School, Maywood, Illinois. Miss Terhune presented the 1949-50 program of the Mathematics Trends Committee. The other members of the committee are:

Miss Kathryn Kennedy, Indiana State Teachers College, Terre Haute, Indiana.

Mr. Donovan Johnson, University of Minnesota, Minneapolis, Minnesota.

Mr. Philip S. Jones, University of Michigan, Ann Arbor, Michigan.

Mr. Vernon Price, Iowa University, Iowa City, Iowa.

The program of the committee is to find and report what is being done in four areas.

1. New courses.
2. Reorganization of courses.
3. Changes in sequence.
4. New approaches to the traditional courses.

The next speaker on the program was Dr. James H. Roberts, Physics Depart-

ment, Northwestern University, Evanston, Illinois. His subject was, The Contribution of Mathematics to the Theory and Application of Atomic Energy. He gave a brief review of the historical developments associated with the discovery of atomic energy. He next gave examples of contributions to physics from various branches of mathematics. These examples included elementary mathematics as well as many branches of higher mathematics.

The meeting adjourned at 12:30 P.M.

ENOCH D. BURTON, *Secretary*

PROBLEM DEPARTMENT

CONDUCTED BY G. H. JAMISON

State Teachers College, Kirksville, Mo.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution as on the following pages.

The editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solutions should observe the following instructions.

1. Drawings in India ink should be on a separate page from the solution.
2. Give the solution to the problem which you propose if you have one and also the source and any known references to it.
3. In general when several solutions are correct, the ones submitted in the best form will be used.

Late Solutions

2155. *W. R. Talbot, Jefferson City, M.; Hugo Brandt, Chicago, Ill.*
2157. *David Rappaport, Chicago, Ill.; Dwight Foster, Florida A and M College; W. R. Talbot, Jefferson City, Mo.; A. MacNeish, Chicago, Ill.*
2159. *A. MacNeish, Chicago, Ill.; and W. R. Talbot, Jefferson City, Mo.*
2160. *Hugo Brandt, Chicago, Ill.; Helen Scott, Baltimore, Md.*
2161. *Proposed by Adrian Struyk, Paterson, N. J.*

A regular hexagon $ABCDEF$ is given. AB is extended through B to B' , BC through C to C' , CD through D to D' , etc. Show how to construct equal extensions of such length that the area $A'B'C'D'E'F'$ will be twice the area of $ABCDEF$.

Solution by Aaron Buchman, Buffalo, N. Y.

It is evident that $A'B'C'D'E'F'$ consists of $ABCDEF$ plus six triangles, all congruent to triangle $AA'B'$.

But if area $A'B'C'D'E'F'$ is twice area $ABCDEF$, it follows at once that

$$\text{area } ABCDEF \text{ is equal to six times area of triangle } AA'B'. \quad (1)$$

Let

$$AB=BC=CD=DE=EF=FA=a$$

and let

$$AA'=BB'=CC'=DD'=EE'=FF'=x. \quad (2)$$

Now angle $A'AB' = 60^\circ$. Then, using the formula for the area of a triangle in terms of two sides and the included angle, the formula for the area of a regular hexagon, relation (1), and relation (2), there follows the equation,

$$\frac{6a^2\sqrt{3}}{4} = \frac{6x(a+x)\sqrt{3}}{4}$$

and

$$a^2 = x^2 + ax. \quad (3)$$

Completing the square in the right member of (3)

$$\frac{5a^2}{4} = \left(x + \frac{a}{2}\right)^2. \quad (4)$$

From (4) it follows that if the mean proportional between $(5a)$ and $(a/4)$ is constructed, and if $(a/2)$ is subtracted from this mean proportional, the required segment x will result.

Solutions were also offered by: W. J. Blundon, St. John's, Nfld.; W. R. Talbot, Jefferson City, Mo.; Alan Wayne, Flushing, N. Y.; A. MacNeish, Chicago, Ill.; Nathan Seely, Jr., Arkansas, A.M. & N. College; Warren Shindle, Haughton, N. Y.; C. W. Trigg, Los Angeles City College; Dwight Foster, Florida A and M College; Margaret Joseph, Milwaukee, Wis.; M. M. Dreiling, Collegeville, Ind.; J. Slavin, Brooklyn, N. Y.; Gerald Sabin, University of Tampa; W. J. Cherry; and the proposer; W. R. Smith, Sutton's Bay, Mich.; Hugo Brandt, Chicago.

2162. Proposed by Adrian Struyk, Paterson, N. J.

The line $y = x \tan \alpha$ cuts $x^2 + y^2 = 6x + 8y$ in $O(o, o)$ and in B . If A is $(6, 0)$ show that $AB = 10 \sin \alpha$.

Solution by V. C. Bailey, Evansville, Indiana

The points O, A, B are the vertices of an inscribed triangle of the given circle. The diameter of this circle is 10.

It is known for any inscribed plane triangle that any side divided by the sine of its opposite angle equals the diameter of the circle.

$$\frac{AB}{\sin \alpha} = 10.$$

Then

$$AB = 10 \sin \alpha.$$

Other solutions offered by: W. J. Cherry, Berwyn, Ill.; W. R. Talbot, Jefferson City, Mo.; Gerald Sabin, University of Tampa; A. MacNeish, Chicago, Ill.; Nathan Seely, Jr., Arkansas A. M. & N. College; Warren Shindle, Haughton, N. Y.; C. W. Trigg, Los Angeles College; Francis L. Miksa, Aurora, Ill.; and J. Slavin, Brooklyn, N. Y.; W. J. Blundon, St. John's, Nfld.; Hugo Brandt, Chicago; Victor Rhynard, San Jose, Calif.

2163. Proposed by Roy Wild, University of Chicago.

Show that

$$\frac{1}{\sin^2 \theta} = \frac{1}{\theta^2} + \frac{1}{(2 \cos \theta/2)^2} + \frac{1}{(4 \cos \theta/4)^2} + \frac{1}{(8 \cos \theta/8)^2} + \dots$$

First solution by Dwight L. Forster, Florida, A. and M. College

$$\begin{aligned}
 \frac{2}{\sin^2 \theta} &= \frac{1}{1 + \cos \theta} + \frac{1}{1 - \cos \theta} = \frac{1}{2 \cos^2 \frac{\theta}{2}} + \frac{1}{2 \sin^2 \frac{\theta}{2}} \\
 \frac{2}{\sin^2 \frac{\theta}{2}} &= \frac{1}{2 \cos^2 \frac{\theta}{4}} + \frac{1}{2 \sin^2 \frac{\theta}{4}} \\
 \frac{2}{\sin^2 \frac{\theta}{4}} &= \frac{1}{2 \cos^2 \frac{\theta}{8}} + \frac{1}{2 \sin^2 \frac{\theta}{8}} \\
 \therefore \frac{2}{\sin^2 \theta} &= \frac{1}{2 \cos^2 \frac{\theta}{2}} + \frac{1}{4} \left[\frac{1}{2 \cos^2 \frac{\theta}{4}} + \frac{1}{4} \left\{ \frac{1}{2 \cos^2 \frac{\theta}{8}} + \frac{1}{2 \sin^2 \frac{\theta}{8}} + \dots \right\} + \dots \right] \\
 &= \frac{1}{2 \cos^2 \frac{\theta}{2}} + \frac{1}{2^2 \cos^2 \frac{\theta}{4}} + \frac{1}{2^3 \cos^2 \frac{\theta}{8}} + \dots + \frac{1}{2^{n-1} \sin^2 \frac{\theta}{2^n}} + \dots \\
 \therefore \frac{1}{\sin^2 \theta} &= \frac{1}{\left(2 \cos \frac{\theta}{2}\right)^2} + \frac{1}{\left(4 \cos \frac{\theta}{4}\right)^2} + \frac{1}{\left(8 \cos \frac{\theta}{8}\right)^2} + \dots + \frac{1}{2^n \sin^2 \frac{\theta}{2^n}} + \dots \\
 &= \frac{1}{\theta^2} + \frac{1}{\left(2 \cos \frac{\theta}{2}\right)^2} + \frac{1}{\left(4 \cos \frac{\theta}{4}\right)^2} + \frac{1}{\left(8 \cos \frac{\theta}{8}\right)^2} + \dots \text{ since} \\
 &\quad \lim_{n \rightarrow \infty} \frac{1}{2^n \sin^2 \frac{\theta}{2^n}} = \frac{1}{\theta^2}.
 \end{aligned}$$

Second solution by W. J. Blundon, St. John's, Nfld.

Using well-known relationship $\tan A = \cot A - 2 \cot 2A$ we have

$$\begin{aligned}
 \frac{\tan \frac{\theta}{2}}{2} + \frac{\tan \frac{\theta}{2^2}}{2^2} + \frac{\tan \frac{\theta}{2^3}}{2^3} + \dots \text{ to } n \text{ terms} \\
 = \left(\frac{\cot \frac{\theta}{2}}{2} - \cot \theta \right) + \left(\frac{\cot \frac{\theta}{2^2}}{2^2} - \cot \frac{\theta}{2} \right) + \left(\frac{\cot \frac{\theta}{2^3}}{2^3} - \cot \frac{\theta}{2^2} \right) + \dots \\
 + \left(\frac{\cot \frac{\theta}{2^n}}{2^n} - \cot \frac{\theta}{2^{n-1}} \right) = \frac{\cot \frac{\theta}{2^n}}{2^n} - \cot \theta.
 \end{aligned}$$

Now

$$\lim_{n \rightarrow \infty} \frac{\cot \frac{\theta}{2^n}}{2^n} = \lim_{n \rightarrow \infty} \frac{1}{\theta} \cdot \frac{\frac{\theta}{2^n}}{\sin \frac{\theta}{2^n}} \cdot \cos \frac{\theta}{2^n} = \frac{1}{\theta}$$

$$\therefore \frac{\tan \frac{\theta}{2}}{2} + \frac{\tan \frac{\theta}{2^2}}{2^2} + \frac{\tan \frac{\theta}{2^3}}{2^3} + \dots \text{ad inf} = \frac{1}{\theta} - \cot \theta.$$

Differentiating, since the series is uniformly convergent,

$$\frac{\sec^2 \frac{\theta}{2}}{2^2} + \frac{\sec^2 \frac{\theta}{2^2}}{2^4} + \frac{\sec^2 \frac{\theta}{2^3}}{2^6} + \dots = -\frac{1}{\theta^2} + \operatorname{cosec}^2 \theta$$

$$\therefore \frac{1}{\sin^2 \theta} = \frac{1}{\theta^2} + \frac{1}{\left(2 \cos \frac{\theta}{2}\right)^2} + \frac{1}{\left(4 \cos \frac{\theta}{4}\right)^2} + \frac{1}{\left(8 \cos \frac{\theta}{8}\right)^2} + \dots$$

Other solutions were offered by: Francis L. Miksa, Aurora, Ill.; Alan Wayne, Flushing, N. Y.; and Nathan Seely, Jr. Arkansas, A. M. & N. College.

2164. Proposed by R. E. Horton, Los Angeles.

Find the equations of the circles through points (2, 0) and (82/89, 60/79), that are tangent to the circle $x^2 + y^2 = 1$.

Solution by M. M. Dreiling, Collegeville, Indiana

$$x^2 + y^2 + Dx + Ey + F = 0 \quad (1)$$

is the general equation of a circle.

$$x^2 + y^2 = 1 \quad (2)$$

is the equation of the given circle.

Subtracting (2) from (1) we obtain the common chord:

$$Dx + Ey + F + 1 = 0. \quad (3)$$

Substituting (2,0) in (1) we obtain $F = -(4+2D)$; likewise, substituting (82/89, 60/89) in (1) and the value of F just obtained, we obtain: $E = 4 + (8/5)D$.

Now placing these values of D and F in (3) yields:

$$x = \frac{15 + 10D - 20y - 8Dy}{5D}.$$

This value of x substituted in (2) leads to the following equation in y :

$$(89D^2 + 320D + 400)y^2 - (160D^2 + 640D + 600)y + (75D^2 + 300D + 225) = 0.$$

Since the circles are to be tangent, the discriminant of this quadratic in y must be equal to 0. Hence, $(160D^2 + 640D + 600)^2 - 4(89D^2 + 320D + 400)(75D^2 + 300D + 225) = 0$. Upon expansion this becomes: $-D^3(11D^2 - 20D - 175) = 0$, leading to two practical values of D : $D_1 = 5$, $D_2 = -35/11$. Hence, $F_1 = -14$, $F_2 = 26/11$, $E_1 = 12$, $E_2 = -12/11$. The required equations, therefore, are: $x^2 + y^2 + 5x + 12y - 14 = 0$, center $(-5/2, -6)$, radius $15/2$, point of tangency $5/13, 12/13$, and $11x^2 + 11y^2 - 35x - 12y + 26 = 0$, center $(35/22, 6/11)$, radius $15/22$, point of tangency $(35/37, 12/37)$.

Other solutions were offered by: Dwight Foster, Florida A. & M. College; W. J. Cherry, Berwyn, Ill.; W. J. Blundon, St. John's, Nfld.; Francis Miksa, Aurora, Ill.; Roy Broman, Mishawaka, Ind.; Gerald Sabin, University of Tampa; and the proposer.

2165. Proposed by Hugo Brandt, College Park, Md.

In a 5-place table of logarithms for trigonometric functions there is a range in which the log $\cos \alpha$ increases 1 unit in the 5th place, if α decreases $1'$. For which angle is this property most nearly true?

Solution by V. C. Bailey, Evansville, Ind.

Let

$$y = \log \cos \alpha.$$

Then

$$dy = \frac{-\sin \alpha \cdot \log e}{\cos \alpha} d\alpha = -\log e \cdot \tan \alpha \cdot d\alpha$$

$$dy = .00001, \quad d\alpha = -1' = -.00029089 \text{ radians}$$

$$\tan \alpha = -\frac{dy}{\log e \cdot d\alpha} = .07916$$

$$\alpha = 4^\circ 32'.$$

Other solutions offered by: Gerald Sabin, University of Tampa; W. J. Blundon, St. John's Nfld.; and the proposer.

2166. *Proposed by Olive Ireland, St. Albans, Vt.*

In triangle ABC , if D is the mid-point of BC and if Δ is the area, show that

$$\cot ADB = \frac{b^2 - c^2}{4\Delta}.$$

Solution by W. R. Talbot, Jefferson City, Mo.

Since the area of ABC is twice that of

$$ADB, \quad \Delta = \frac{a \cdot AD \cdot \sin ADB}{2}.$$

By the law of cosines

$$b^2 = AD^2 + \frac{a^2}{4} - a \cdot AB \cdot \cos ADC$$

$$c^2 = AD^2 + \frac{a^2}{4} - a \cdot AD \cdot \cos ADB.$$

Since $\cos ADC = \cos ADB$, then $b^2 - c^2 = 2aAD \cos ADB$.

Dividing by $4\Delta = 2aDs$ in ADB gives the desired relation

$$\frac{b^2 - c^2}{4\Delta} = \cot ADB.$$

Other solutions offered by: W. J. Blundon, St. John's, Nfld.; J. Slavin, Brooklyn, N. Y.; C. W. Trigg, Los Angeles City College; Nathan Seely, Jr., Arkansas A. M. & N. College; Roy Broman, Mishawaka, Ind.; Margaret Joseph, Milwaukee, Wis.; M. M. Dreiling, Collegeville, Ind.; Francis Miksa, Aurora, Ill.; Aaron Buchman, Buffalo, N. Y.; Richard Schubert, Cicero, Ill.; David Rappaport, Chicago, Ill.; V. C. Bailey, Evansville, Ind.; W. J. Cherry, Berwyn, Ill.; Dwight L. Foster, Florida A. & M.; Hugo Brandt, Chicago; Victor Rhynard, San Jose, Calif.

HIGH SCHOOL HONOR ROLL

The Editor will be very happy to make special mention of high school classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

Editor's Note: For a time each high school contributor will receive a copy of the magazine in which the student's name appears.

For this issue the Honor Roll appears below.

2160. *Hwa-Chang Lu, Convent, N. J.*

2161. *Myrtle Sharp, Joanne Meyer, Nancy Kauffung—all from St. Mary's Academy, Milwaukee.*

PROBLEMS FOR SOLUTION

2179. *Proposed by Adrian Struyk, Paterson, N. J.*

If the square of the arithmetic mean of two numbers is equal to the sum of the squares of their geometric and harmonic means, then the two numbers and their arithmetic and harmonic means can be arranged in geometric progression.

2180. *Proposed by Hugo Brandt, University of Md.*

Find the sum, S_n , of the first n terms of the sequence: 0, 7(1), 26(3), 63(9), 124(27).

2181. *Proposed by Howard D. Grossman, New York.*

Show how to pass a cube through another one of equal volume, that is, show how to cut a hole in a cube through which another cube of equal size can pass

2182. *Proposed by Doris Crane, Chatfield, Minn.*

Eliminate A between the two equations

$$x = 3 \sin A - \sin 3A$$

$$y = \cos 3A + 3 \cos A.$$

2183. *Proposed by Clara Lane, Chevy Chase, Md.*

If $x/y = \cos A / \cos B$, prove:

$$x \tan A + y \tan B = (x+y) \tan \frac{A+B}{2}.$$

2184. *Proposed by C. W. Trigg, Los Angeles.*

1. What is the smallest number of creases necessary in order that an equilateral triangle may be folded, without cutting, into a regular tetrahedron with no open edges? (An open edge is one through which there is no straight line access to the centroid of the solid.) How may the folding be accomplished?

2. Show that no more creases are necessary to fold the triangle into a semi-regular hexahedron with two open edges.

3. Show that no more creases are necessary to fold the triangle into a regular octahedron with one open face.

ATOMIC ENERGY IS SAFER TO WORK WITH THAN CHEMICALS

Atomic energy, considered by many to be the greatest source of peril to mankind, can actually be far safer to work with, when tamed and confined in a laboratory, than chemicals or ordinary munitions. Given the proper safety measures U. S. Atomic Energy Commission officials told the American Society of Mechanical Engineers, atomic laboratories have proved far safer than factories manufacturing or experimenting with the old-fashioned kinds of explosives.

George G. Manov and David O. Lintz, of Oak Ridge, told the mechanical engineers that not one death or permanent radiation injury has occurred in Atomic Energy Commission installations as a result of working with atomic energy.

However, the two atomic officials declared, increasingly wide use of radioactive by-products of atomic energy does present a potential health hazard, a hazard which can be controlled, provided proper safety measures are taken.

BOOKS AND PAMPHLETS RECEIVED

TELEVISION FOR RADIOMEN, by Edward M. Noll, *Television Instructor in the Technical Institute of Temple University in Philadelphia*. Cloth. Pages xii + 595. 15 × 23.5 cm. 1949. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price \$7.00.

EVERYDAY GENERAL MATHEMATICS, BOOK ONE, by William Betz, *Specialist in Mathematics, Rochester, New York*; A. Brown Miller, *West Technical High School, Cleveland, Ohio*; F. Brooks Miller, *Formerly Shaker Junior High School, Shaker Heights, Ohio*; Elizabeth B. Mitchell, *Charlotte High School, Rochester, New York*; and H. Carlisle Taylor, *Head of the Department of Mathematics, Benjamin Franklin High School, Rochester, New York*. Cloth. Pages xii + 436. 15 × 23 cm. 1949. Ginn and Company, Statler Building, Boston 17, Mass. Price \$2.40.

A CHILD'S USE OF NUMBER, GRADES 1 AND 2, by Virgil S. Mallory, *Head of Department of Mathematics and Instructor in the Demonstration School, State Teachers College, Montclair, New Jersey*; Dennis H. Cooke, *President of High Point College, High Point, North Carolina*; and Esther F. Taylor, *Primary Teacher, Denver Public Schools*. Cloth. Pages vi + 189. 13 × 20 cm. 1949. Benj. H. Sanborn and Company, 221 East 20th Street, Chicago 16, Ill. Price \$1.40.

GUIDANCE HANDBOOK FOR TEACHERS, by Frank G. Davis, Ph.D., *Professor of Education, Bucknell University, Lewisburg, Pennsylvania*, and Pearle S. Norris, M.A., *Counselor, Public Schools, Philadelphia, Pennsylvania*. Cloth. Pages x + 344. 15 × 23 cm. 1949. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York 18, N. Y. Price \$3.50.

MATHEMATICS DICTIONARY, Edited by Professor Glenn James of the University of California at Los Angeles, and Dr. R. C. James of the University of California at Berkeley. Cloth. Pages v + 432. 15 × 23 cm. 1949. D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York 3, N. Y. Price \$7.50.

GIANT BRAINS OR MACHINES THAT THINK, by Edmund Callis Berkeley, *Consultant in Modern Technology*. Cloth. Pages xvi + 270. 14 × 21 cm. 1949. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price \$4.00.

ATLAS OF DRAWINGS FOR CHORDATE ANATOMY, by Samuel Eddy, *Professor of Zoology, University of Minnesota*. Paper. 189 Illustrations. 20 × 28 cm. 1949. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price \$3.50.

LABORATORY EXPERIMENTS IN COLLEGE PHYSICS, by Cicero Henry Bernard, *Associate Professor Physics, The Agricultural and Mechanical College of Texas*. Paper. Pages vii + 291. 18.5 × 26 cm. 1949. Ginn and Company, Statler Building, Boston 17, Mass. Price \$2.75.

EDUCATORS GUIDE TO FREE SLIDEFILMS, Compiled and Edited by Mary Foley Horkheimer, and John W. Diffor, M.A., *Visual Education Director, Randolph High School, Randolph, Wisconsin*. Paper. Pages iv + 114. 20 × 27.5 cm. 1949. Educators Progress Service, Randolph, Wis. Price \$3.00.

WILEY BOOKS. 1950 Catalog. Paper. 248 pages. 13 × 21 cm. John Wiley and Sons, Inc., 440 Fourth Ave., New York 16, N. Y.

Fossils of three different races of ape-men were found in South Africa; one of giants two and one-half times as big as today's average human being; another, a race of small, gracefully built ape-men weighing about 100 pounds each; and a third type more nearly human than some of those previously found.

BOOK REVIEWS

FREQUENCY MODULATION, by Nathan Marchand, *Consultant to New York University Cardiological Department*. Cloth. Pages xii+409. 14.5×23 cm. 1948. Murry Hill Books, Inc., 232 Madison Avenue, New York 16, N. Y. Price \$5.00.

This book gives the most comprehensive treatment of the subject that has come to my desk. It is put up especially for the practical man but the list of references and set of good questions at the close of each chapter help to make it suitable for a class textbook. One who has a fair knowledge of amplitude modulation will have no difficulty with this text. The many schematic diagrams, numerous photographs, and graphical representations go a long way in clearing all difficulties. But not everything can be made clear and usable without relying upon the mathematics underlying the theory. No attempt is made to explain without the use of mathematical symbols and equations. Even Bessel functions are used but no derivation or mathematical proof of their existence is given. For those not well up in the use of vectors, or phasors, the appendix should be studied first.

The book starts off with a discussion of the different types of modulation, comparing them in fidelity, noise, and interference. This requires a section of about ninety pages. Following this is the treatment of transmitters of both direct and phase-to-frequency modulation types, requiring approximately sixty pages. Then we come to a large and very important part of the book devoted to a discussion of f-m receivers. This is given in great detail with many diagrams and excellent explanations and comparisons. Antennas for both transmission and receiving are also included. A short section giving the installation, care, and use of mobile equipment in about twenty-four pages completes the discussion of theory and practice. The book closes with an excellent division for the practical man. This covers the test equipment and servicing, pointing out the principal differences between a-m and f-m equipment.

G. W. W.

CHEMISTRY FOR THE NEW AGE, by Robert H. Carleton, *Executive Secretary, National Science Teachers Association*; and Floyd F. Carpenter, *Principal of Stivers High School, Dayton, Ohio*. Cloth. Pages xiv+688. 16×22 cm. 1949. J. B. Lippincott Company, Chicago, Illinois. Price \$3.20.

The authors of this excellent text have both been high school teachers of chemistry and are thoroughly familiar with the problem of presenting the subject matter of chemistry to high school students. In addition, the authors had the editorial assistance of W. R. Teeters, Director of Education, St. Louis Public Schools.

The material of this text is presented in nine large units divided into twenty-two chapters. The chapters have been broken down into fifty-eight unit-problems to facilitate learning and teaching.

The text possesses several outstanding features. Unlike most high school texts it faces the problem of presenting material to both non-college and college-preparatory students. Chemistry teachers of today are finding it necessary to differentiate instruction for these two types of students. The text will aid a teacher in meeting this difficult problem.

The text is highly illustrated with new and up-to-date photographs and diagrams. The 280 illustrations add materially to the readability of the text.

A desirable feature is the "Highlights" and "A Test of Your Knowledge and Understanding" at the end of each unit-problem. In addition, the "Application Exercises" and "Problems" at the end of each chapter, add considerably to the usefulness of the text for review purposes.

The subject matter and activities of this text were selected for their potential value in promoting attainment of three major types of objectives: (1) growth in knowledge and understanding of the more important facts, concepts, and principles of chemistry, (2) growth in the skills and abilities involved in scientific prob-

lem solving, and (3) development of attitudes and appreciations characteristic of the scientific habit of mind. It is encouraging to find a text, which emphasizes the modern objectives of science instruction.

KENNETH E. ANDERSON
University of Kansas

THE PHYSICAL PRINCIPLES OF THE QUANTUM THEORY, by Werner Heisenberg, *Professor of Physics, University of Leipzig*. Translated into English by Carl Eckart and Frank C. Hoyt, Department of Physics, University of Chicago, Cloth. Pages xii+186. Index. $5\frac{1}{2} \times 8$. 1930. Dover Publications Inc.; Price \$2.50.

The spectacular advances in *pure* physics in the last 20 years are due in very large part to Heisenberg's development of the new quantum mechanics. Indeed, among contemporary physicists and philosophers, few contributions have had such far-reaching consequences. The matrix theory and the Uncertainty Principle are foundational and must inevitably go down as monumental achievements in human thinking. With Heisenberg we have one of the most profound chapters in the history of physical thought.

This small volume embraces the lectures given by Heisenberg at the University of Chicago in the spring of 1929. In these, ably put into English by the translators, Heisenberg gives a complete *physical* picture of the quantum theory, and in so doing beautifully reviews the contributions of Compton, Schrödinger, Einstein, Thomson, Bohr, and the others. Roughly 100 pages are given to the physical principles; the mathematical apparatus, which is fairly formidable, is reserved for the last half of the book. Accordingly, readers not adequately equipped with Hamiltonian functions, Hermitian matrices, and Hilbert space may read the *descriptive* physics with not too much travail.

Everyone having to do with science, especially the physical sciences, should, reading this monograph, experience the thrill of communion with one of the greatest events in scientific thought. It is equivalent to reading one of the "great books."

In recognition of the "creation" of this quantum mechanics Heisenberg received the Nobel award in 1932.

JULIUS SUMNER MILLER
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THE THEORY OF GROUPS AND QUANTUM MECHANICS, by Hermann Weyl, *Professor of Mathematics in the University of Göttingen*. Translated from the Second (Revised) German Edition by H. P. Robertson, *Associate Professor of Mathematical Physics in Princeton University*. Cloth. Pages xxii+422. $5\frac{1}{2} \times 8$. Appendix. Bibliography. Index. 1931. Dover Publications, Inc. Price \$4.50.

The theory of groups and "abstract algebra" are preeminently pure mathematical domains in human thinking, but their application to quantum physics has led to formidable advances in physical theory. In fact, this mathematical tool *established* the foundations of the new quantum physics, which were first formulated by Planck's introduction of energy quanta in 1900 and extended in Bohr's quantum theory of atomic processes, proposed in 1913. It soon developed that the problems of the new quantum physics were not failures in the *physical concepts* but rather failures in the pictures of space and time.

This book treats in the most scholarly fashion the mathematical and theoretical foundations of the new quantum physics. The mathematical sections are formidable and demand a fluency with matrix calculus, Lie's theory of groups, and other such "ethereal" matters. The physics portions, however, that is, the expository sections, read well. The book is not for the beginner nor for the layman! It is strictly for the expert.

Professor Weyl is a mathematician of the first rank, and very beautifully shows how pure mathematical thought assists in unveiling the secrets of Nature.

The translation is no less of an achievement and Professor Robertson deserves the highest accolade.

JULIUS SUMNER MILLER

MATHEMATICS FOR ELECTRICIANS, by Martin H. Kuehn, *Principal of Technical High School, Buffalo, New York*. Cloth. Pages xi+302. Appendix. Third Edition. 1949. McGraw-Hill. Price \$2.80.

This book accomplishes its purpose in a very creditable fashion. It is designed explicitly for teachers and students in vocational schools who need to know how to get the answer. In this regard it should serve the electrician or mechanic whose formal schooling may be brief or inadequate.

The text covers the fundamentals of arithmetic and algebra altogether adequately and goes then at once to their applications in Ohm's Law, series and parallel circuits, power, generator and motor problems, and Kirchhoff's Laws. Some elementary geometry is given as well as a chapter on slide rule and on graphs. The treatment of vectors and complex quantities leads at once to alternating current circuits, and these sections are very well done. Three-phase circuits are very briefly suggested.

The entire treatment is essentially sound pedagogically. The illustrative examples are very well chosen and there is an abundance of student exercises.

Trigonometric and logarithmic tables are appended, and the answers to all the problems are given.

The text is deserving of success and will probably have it.

JULIUS SUMNER MILLER

PLANE AND SPHERICAL TRIGONOMETRY, by J. Shibli, *The Pennsylvania State College*. Cloth. Pages xii+262+94 (trigonometric and logarithmic tables). 15×21 cm. 1949. Ginn and Company, Boston. Price \$3.00.

This would be termed a traditional text book in trigonometry. The treatment takes up the acute angle first. There is an ample supply of problems, with applications to many fields. The author in the preface points out certain changes in the present revision: extension of some explanatory material, addition of new exercises, placing material on radian measure, graphic representation, and inverse functions in separate chapters.

The author discusses degree of accuracy and significant figures, but one might have the feeling that this is merely because this is customary—within five pages after he has pointed out that no result can be more accurate than the least accurate of the measurements upon which it is based we find data for a triangle given to three significant figures yet the answer is given to four significant figures (this is by no means an isolated case). In discussing interpolation in a five place logarithm table it is stated that "it is sufficient to obtain results to the nearest figure in the fifth place"; certainly one might conclude that it is possible to obtain greater accuracy. Again, in discussing logarithms, the author states that "the logarithm of a number between 0.1 and 1 is -1 plus a decimal." It may be, it may also be -2 plus a (negative) decimal; it may also be a negative decimal fraction less than unity in numerical value. On page 39 it is stated that the mantissa is the same for all numbers having the same succession of digits, on page 45 reference is made to negative mantissas—there seems to be contradiction here.

On page 118 it is stated that certain relations are identities because they are true for all possible values of the angle; since 90° is a possible value of the angle, yet division by zero and the tangent of the angle are both involved, it is hard to see how the relations are true. The definition of the principal value of the inverse trigonometric functions makes no mention of the fact that other definitions are in use. Granted that there may be good reason for the selection of one type of definition, it is only fair to the student to warn him that he may encounter alternative and non-equivalent definitions.

CECIL B. READ
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THE WORLD AS I SEE IT, by Albert Einstein. Translated by Alan Harris. Cloth. Pages xiii + 112. 9.5 × 16.5 cm. 1949. The Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price \$2.75.

Albert Einstein is a name known to everyone but few know much about him. Many think of him as a mathematical genius who never thinks or talks in language the average man can understand. This book gives only a selection of his letters, addresses, and articles on topics of great interest to the masses of people throughout Europe in the years between the great World Wars. Now he has become one of us in the United States of America and we should all know him as a citizen and know his views on political liberty, on toleration of thought and religion. The original form of this book includes the essays on relativity and other mathematical subjects. These have been eliminated so as to give the general reader a knowledge of the human side of a great man. Part I of this book, headed *The World as I See It*, gives a number of his short letters, addresses, and articles. A few of these you will not fully appreciate without knowing a bit of history not here given, but the most, such as "Religion and Science," "Education and Educators," "To the School Children of Japan," and "Some Notes on My American Impressions," will interest everyone. Part II, *Politics and Pacifism*, gives his views on the European situation, the disarmament question, culture and prosperity. Part III is a very short but highly significant section giving his correspondence with the Prussian Academy of Science in 1933. Part IV consists of his letters and addresses concerning the formation of the Jewish state in Palestine and his hopes for the future of the Jews.

G. W. W.

SOUND WAVES, TOO HIGH-PITCHED TO HEAR, ARE VALUABLE LABORATORY, INDUSTRIAL TOOLS

Sound waves too rapid to affect the human ear as sound are being used by chemists and engineers in a great variety of applications ranging from examining steel for flaws to assisting chemical reactions.

Ultrasonics is the name applied to these high-pitch sound waves. It is possible to shoot them through 30 feet of steel and find a small flaw, the American Institute of Chemical Engineers was told by Dr. Dudley Thompson, Virginia Polytechnic Institute, Blacksburg, Va. Among chemical applications, they are employed in the emulsification of various liquids, mercury and water, and of molten metals and water.

In the perfume industry, ultrasonic emulsification is used to avoid the use of organic solvents that might be harmful to the skin. Improved fuel for automobile and other internal combustion engines may come by emulsifying small quantities of water and water solvents in hydrocarbons by means of ultrasonic waves. Easy ignition or anti-detonating properties would be promoted, it is thought.

POP SORGHUM FOR MOVIE FANS

Popcorn may soon have a rival: pop sorghum which can be chewed noiselessly, without getting caught in the teeth, is vying to become the number one movie confection.

Although sorghum grains make a smaller puff than popcorn, their thinner hull leaves no husk to lodge between the teeth. Pop sorghum is more tender in consequence and when chewed produces no crackling sounds to detract from the sound track.

Such at least are the claims made for pop sorghum by plant breeders of the Texas Agriculture Experiment Station here who have developed what they think may some day rival popcorn for the public's favor.

The idea of popping sorghum is not new. At least 50 years ago farm boys were taking the grains of sorghum, raised extensively for cattle fodder, and roasting them over open fires. The Chinese make a confection of sorghum by puffing it with steam, something like puffed rice.